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PRELIMINARY INSTRUCTION MANUAL

TELEMETRY RECEIVER
MODEL 410A

00 MHz CHNL 423

SCIENTIFIC-ATLANTA, INC.

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SCIENTIFIC-ATLANTA, INC.
P. O. Box 13654, Atlanta, Ga. 30324

PRELIMINARY INSTRUCTION MANUAL

TELEMETRY RECEIVER
MODEL 410A

FREQ RANGE 2200 - 2300 MHZ MODEL 423

MODEL 455 - Pre Detection Record Translator

MODEL 1.5LP - IF FILTER

H/P 675A/676

MODEL 440 - FM DEMODULATOR

MODEL 440 - Fm Demodulator

MODEL 1.0LP - IF FILTER

MODEL 1.0LP - IF FILTER

MODEL .5LP - IF FILTER

MODEL .5LF IF FILTER

First Edition
March 1969

Additional copies available at $25

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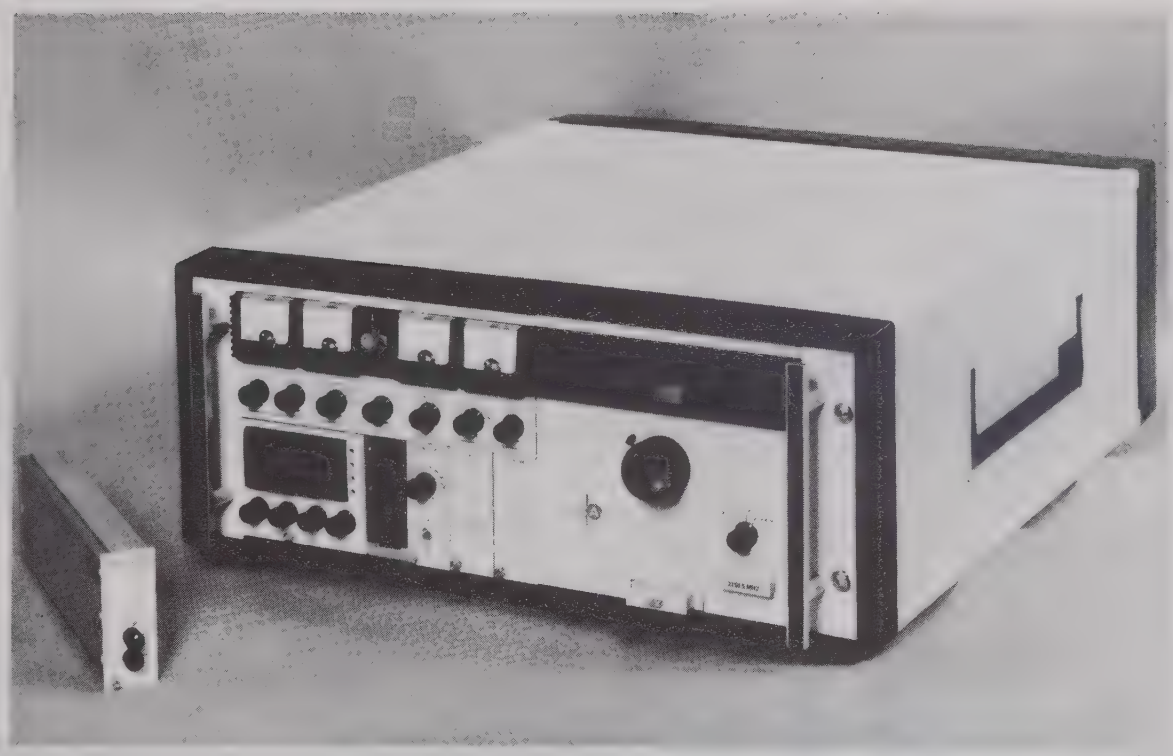


Figure 1-1. Model 410A Telemetry Receiver

SECTION 1
GENERAL INFORMATION

1.1 GENERAL

This manual contains the information necessary to install and operate the Scientific-Atlanta Model 410A Telemetry Receiver. Electrical schematics are also included in section 5.

1.2 PURPOSE OF EQUIPMENT

The Model 410A Telemetry Receiver is a double-conversion data-receiving system designed for reception of amplitude-, frequency-, and phase-modulated telemetry signals at frequencies up to 6 GHz.

1.3 GENERAL DESCRIPTION

The Model 410A Telemetry Receiver (figure 1-1) utilizes a totally modular design. This concept provides great versatility in the reception of various tuning ranges and data formats. The basic telemetry receiver is the foundation of a completely modular receiving system.

The basic unit contains the power supplies, metering and control circuitry, AGC and AFC circuitry, IF amplifiers, AM detectors, video filters, and signal amplifiers. All circuit components are mounted within readily accessible plug-in modules with 50-ohm signal interfaces to assure interchangibility.

Space is provided on the front panel for the insertion of an RF tuning head, IF filters, PM or FM demodulators, predetection record and playback translators, a spectrum analyzer, and other standard or special accessories. Additional flexibility is provided by the selection of basic receiver options such as 10-MHz calibrator, manual gain control, search and lock AFC, selectable AFC and AGC time constants, and a carrier acquisition indicator. As many as four of these options may be employed simultaneously.

An auxiliary housing unit can be utilized for insertion of external plug-in modules if the main receiver chassis is full. This housing contains a built-in power supply. The units can be mounted in a standard 19-inch equipment cabinet or bench mounted if desired. Electrically, the telemetry receiver consists of an RF tuner, second conversion circuitry, IF filters, AM detector, data demodulator, video section, metering section, and the selected accessories.

The RF tuner couples the input signal from the antenna to the 410 Receiver. The UHF tuners provide a high dynamic range with reduced intermodulation by employing an integrated preselector and double-balanced first mixer. This design, coupled with a 60-MHz first IF, minimizes spurious responses and undesired radiation while providing the 410 Receiver with a low noise figure. VHF tuners provide wide dynamic range and a low noise figure by employing FET circuitry.

The 60-MHz signal from the RF tuner is the input to the second conversion section. The second conversion section amplifies the signal and converts the 60-MHz to a 10-MHz signal by a double-balanced mixer. The second local oscillator operates in the VFO, AFC, or APC mode to provide vernier tuning. A crystal controlled mode is also available. In the playback or calibrate mode, the second local oscillator is disabled.

The 10-MHz signal from the second conversion section is routed through plug-in IF filters. These filters are interchangeable or switch selectable and determine the predetection bandwidth of the receiver. The filters are selected in accordance with the data bandwidth to be received. The linear phase filters are of the Bessel type to reduce data distortion to an absolute minimum. Constant amplitude (Butterworth) filters are also available in standard bandwidths from 10 kHz to 3.3 MHz.

The 10-MHz signal is coupled simultaneously to the AM detector and the data demodulator. The AM detector provides AM video and AGC control. A linear 10-MHz output is provided as an external output for recording or accessory operation.

The data demodulator detects the FM or PM components of the 10-MHz signal. The FM demodulators feature high linearity and excellent capture performance. The PM demodulators are characterized by extended carrier tracking thresholds and linear demodulation of PM formats. A limited 10-MHz external output is supplied from the demodulator.

The video signal from the demodulators is the input to the video section. The signal is filtered by linear phase filters having selectable bandwidths from 20 kHz to 2.0 MHz.

A highly stable video amplifier provides the selection of ac or dc coupling in the video output and amplifies the signal to the receiver output level.

The metering section provides a display of the signal characteristics and receiver functions. Receiver tuning error, measured in kilohertz, is displayed by the zero center tuning meter. Signal strength, measured in Microvolts, is indicated as well as carrier frequency deviation, phase deviation, or percentage of AM modulation. The video level is indicated in volts.

Plug-in space is provided for two accessory modules. Commonly used accessories are the spectrum analyzer and predetection recording and playback translator units. The spectrum analyzer can monitor an input spectrum from 100 kHz to 4 MHz wide centered about the 60-MHz IF. A logarithmic amplifier permits simultaneous observation of signals differing in amplitude as much as 40 dB. Carrier and sideband malfunctions and interference are easily seen on the spectrum analyzer. The predetection record translator converts the 10-MHz IF to a third IF compatible with standard magnetic tape recording center frequencies. The playback translator converts the recording frequency to 10-MHz for demodulation by the receiver.

Other accessories are available for use with the Series 410 Telemetry Receiver. The module extension set permits a module to be electrically connected to the basic receiver unit while physically removed from the receiver. This configuration permits the module to be extended for inspection and/or maintenance. The auxiliary module housing unit is basically another unit into which additional plug-in modules for receiver operation can be mounted. Blank tuner modules, a blank internal module, and blank front panel modules are available for insertion into a blank panel space in the basic receiver unit.

1.4 TECHNICAL CHARACTERISTICS

The Model 410A Telemetry Receiver technical characteristics are listed in table 1-1.

TABLE 1-1. TECHNICAL CHARACTERISTICS, MODEL 410A TELEMETRY RECEIVER

Characteristic	Specification
Basic Receiver	
Type	Double conversion, superhetrodyne, modular, all solid state
Tuning Range	10 MHz to 6 GHz with plug-in tuning heads
Reception Modes	AM, FM, PM, all standard IRIG formats
First IF Freq	60 MHz
Second IF Freq	10 MHz
RF Input	Signal input, 50 ohms
Video Output	AM, FM, PM video, 75 ohms
AGC Voltage	0 to 8V dc
RF Tuner	
Impedance	50 ohms
VSWR	2:1 maximum
Preselector Bandwidth	
UHF Tuners	15 MHz nominal
VHF Tuners	8 MHz nominal
Dynamic Range	To 0 dBm
Local Oscillator:	
Modes	VFO, XTAL, OFF
Stability	XTAL; 0.00025% with oven, 0° -50°C
VFO:	0.001%/°C
Intermodulation	+10 dBm intercept point
Image Rejection	Greater than 80 dB
IF Rejection	Greater than 90 dB
Spurious Responses	Greater than 70 dB down
LO Radiation	Less than -77 dBm
Dial Accuracy	Better than 0.5%
Second Local Oscillator	
Crystal Mode	0.005% stability
VFO Mode	±250-kHz tuning range, 0.001%/°C stability

TABLE 1-1. TECHNICAL CHARACTERISTICS, MODEL 410A TELEMETRY RECEIVER-continued

Characteristic	Specification
Second Local Oscillator-continued	
AFC Mode	±250-kHz acquisition range
APC Mode	±250-kHz tracking range
Playback	Disables second local oscillator
Calibrate	Provides 10-MHz calibration signal (optional)
IF Filters	
Linear Phase:	
Phase Linearity	Better than 3° over entire 3 dB bandwidth
Intermodulation Signal Ratio	−45 dB, typical
Shape Factor	4.0:1 nominal
Constant Amplitude:	
Passband Flatness	±0.5 dB
Shape Factor	3.0:1 Nominal
AM Detector	
Freq Response	10 to 500 kHz, or 1/2 IF bandwidth
Distortion	3% at 70% modulation
FM Demodulators	
Model 440:	
Bandwidth	Standard
Deviation	15 kHz to 1.5 MHz
IF Bandwidths	50 kHz to 4.0 MHz
Model 441:	
Bandwidth	Narrow
Deviation	2 to 50 kHz
IF Bandwidths	10 to 100 kHz
Model 445:	
Bandwidth	Wide
Deviation	100 kHz to 2.0 MHz
IF Bandwidths	200 kHz to 4.0 MHz

TABLE 1-1. TECHNICAL CHARACTERISTICS, MODEL 410A TELEMETRY RECEIVER-continued

Characteristic	Specification
FM Demodulators-continued	
AM Rejection	50% AM referenced to 1/4 of maximum deviation: 50 dB to 10 kHz, decreases 6 dB/octave above 10 kHz
Limiting	20 dB minimum
Phase Demodulators	
Model 443:	
Type	Standard
Deviation	±10° to ±80°
IF Bandwidth	10 kHz to 4.0 MHz
Demodulation - Linearity	2% to ±30°
	5% to ±60°
Model 444:	
Type	Wide Angle
Deviation	±20° to ±135°
IF Bandwidth	10 kHz to 4.0 MHz
Demodulation - Linearity	5% to ±120°
Demodulation Modes:	
Long Loop	PM or synchronous AM
Short Loop	PM or synchronous AM
AM	Noncoherent AM
Phase Lock Characteristics:	
Loop Bandwidth	10, 30, 100, 300, 1000 Hz
Tracking Range	±250 kHz
Fine Tuning Range	±250 kHz
Locking Threshold	−18 dB SNR in IF, long loop mode
Phase Error, Static	10° maximum
Video Filters	
Type	Linear phase, 18 dB/octave roll-off
Bandwidths	20 kHz, 50 kHz, 100 kHz, 200 kHz, 500 kHz, 1.0 MHz, bypass

TABLE 1-1. TECHNICAL CHARACTERISTICS, MODEL 410A TELEMETRY RECEIVER-continued

Characteristic	Specification
Video Amplifier	
Coupling	AC or DC
Frequency Response:	
AC	5 Hz to 1.5 MHz, ±1 dB
DC	DC to 1.5 MHz, ±1 dB
Distortion	0.5% at 4.0V P-P output
Output Level	0 to 8V P-P
Metering, Controls, and Indicators	
Signal Strength	0 to 100 dB above noise
Tuning	Indicators correctly for all IRIG formats, error indicated in kilohertz
Modulation:	
FM	Indicates deviation in kilohertz
PM	Indicates deviation in degrees
AM	Indicates 0 to 100% modulation
Output Level	0 - 10V P-P
Indicators	Aural Monitor Power ON
Controls	Power on/off Second LO Mode Fine Tuning Video Bandwidth Video Output Level Audio Output Level Video Coupling AGC Fast/Slow
Inputs/Outputs	
RF Input	Signal input, 50 ohms
First Local Oscillator	Monitor output, 50 ohms
Second Local Oscillator	Monitor output, 50 ohms
10 MHz Linear	10 MHz output for recorder or accessories, 50 ohms
10 MHz Limited	10 MHz output for recorder or accessories, 50 ohms

TABLE 1-1. TECHNICAL CHARACTERISTICS, MODEL 410A TELEMETRY RECEIVER-continued

Characteristic	Specification
Inputs/Outputs-continued	
60 MHz	60 MHz output for spectrum analyzer or accessories, 50 ohms
Video Output	AM, FM, PM video, 75 ohms
Playback	10 MHz playback input
Auxiliary 1 & 2 In	Inputs to accessory modules
Auxiliary 1 & 2 Out	Outputs from accessory modules
AGC	AGC voltage, 0 to 8V dc
AM	AM detector, independent of video amplifier
Environmental	
Operating Temp	0 to 50° C
Humidity	0 to 90% relative humidity
Power	50 to 400 Hz, 105 to 125V ac, 50 watts
Physical	
Size	
Height	7 in
Width	19 in
Depth	19.5 in
Weight	55 lb
Mounting	Standard RETMA panel, provisions for slides
Color (Standard)	Grey, color chip no. 26440, per FED-STD-595
Applicable Military Specifications	
RFI	MIL-STD-461 (supercedes MIL-STD-826, MIL-I-26600, MIL-I-6181)
Quality Assurance	MIL-Q-9858
Workmanship, Materials Processes	MIL-E-4158 as a guide

1.5 EQUIPMENT SUPPLIED

Table 1-2 lists the units supplied or available for use with the Model 410A Receiver.

TABLE 1-2. EQUIPMENT AVAILABLE FOR MODEL 410A TELEMETRY RECEIVER

RF Tuners	
Model 422	1435-1540 MHz
Model 423	2200-2300 MHz
Model 424	1700-1850 MHz
Model 425	120-150 MHz
Model 426	285-410 MHz
Model 427	215-320 MHz
Crystals	
Model 420XO	with Oven
Model 420XW	without Oven
Model 420XA	Adapter
IF Filters	
Model 430-LP	Non-Switchable, Linear Phase
Model 430-CA	Non-Switchable, Constant Amplitude
Model 431-LP	Switchable, Linear Phase
Model 431-CA	Switchable, Constant Amplitude
Standard Bandwidths*	
Linear Phase	100, 200, 250, 300, 500, 750, 1000, 1500, 2500, 3300 kHz
Constant Amplitude	10, 50, 100, 200, 500, 750, 1000, 1500, 2500, 3300 kHz
Demodulators	
Model 440	FM, Standard Bandwidth
Model 441	FM, Narrow Bandwidth

*Special bandwidths available to 4000 kHz.

TABLE 1-2. EQUIPMENT AVAILABLE FOR MODEL 410A TELEMETRY RECEIVER-continued

Demodulators-continued

Model 442	Phase-Lock Tracking
Model 443	PM, Standard
Model 444	PM, Wide Angle
Model 445	FM, Wide Bandwidth

Accessories

Model 450	Spectrum Analyzer
Model 451	60-30 MHz Converter
Model 455	Predetection Record Translator
Model 455-1	900, 450, 225 kHz
Model 455-2	450, 225, 112.5 kHz
Model 455-3	900, 600, 450 kHz
Model 456	Predetection Playback Translator
Model 456-1	900, 450, 225 kHz
Model 456-2	450, 225, 112.5 kHz
Model 456-3	900, 600, 450 kHz
Model 457	Predetection Playback Demodulator

Basic Receiver Options

Model 407C	Carrier Indication
Model 407F	Search/Lock AFC
Model 407G	AGC Time Constant
Model 407J	AFC Time Constant
Model 407M	Manual Gain Control
Model 407X	10 MHz XTAL Calibrator

SECTION 2
INSTALLATION

2.1 GENERAL

Installation of the basic receiver unit will conform to standards designated by existing conditions and the installing agency as to unit location and type of installation. This section contains suggestions and factors to consider before installing the unit. Close adherence to these suggestions will assure a more satisfactory performance from the equipment.

2.2 UNPACKING AND INSPECTION

Exercise caution when unpacking the unit. Carefully open each carton and inspect the unit for shipping damage. If a claim for damage is to be made, save the packing material and shipping carton to substantiate the claim. File the claim with the carrier and notify the local Scientific-Atlanta sales representative immediately. Do not return the unit until shipping instructions have been received from the factory. After all units have been removed from the shipping cartons, check all packing material for small components that may have been wrapped separately. Compare the units received against the packing list. Replace all packing material in the shipping cartons and save the materials for future unit storage or reshipment.

2.3 INSTALLATION

2.3.1 GENERAL

A standard 19-inch (panel width) equipment cabinet is required for mounting of the receiver unit. The rack should have a depth of 24 inches. If desired, the unit can be bench mounted, thus eliminating the need for the equipment cabinet. The unit will weigh approximately 55 pounds if a full complement of plug-in modules is employed.

2.3.2 UNIT INSTALLATION

Unit installation is to be accomplished as follows:

a. Select the basic receiver unit location.

b. Secure the basic unit to the equipment cabinet or bench.

c. Connect the ac power to the appropriate connector (J114). The power cord, a twist-lock type connector, is supplied with each receiver.

d. Connect the RF input to the RF IN connector (J101).

e. Refer to table 2-1 for a list of the connectors and their function.

TABLE 2-1. MODEL 410A TELEMETRY RECEIVER CONNECTORS AND FUNCTIONS

Note: All connectors BNC except J113 which is M53102A-145-1S

Ref Desig	Name	Function
J101	RF IN	The RF input signal is connected to this point. 50 ohms.
J102	1ST LO	Output of first local oscillator for frequency monitoring purposes. 50 ohms, isolated.
J103	2ND LO	Output of second local oscillator for frequency monitoring purposes. 50 ohms, isolated.
J104	60 MHz	First IF amplifier output which drives the spectrum analyzer and should be connected to J109 if spectrum analyzer is used.
J105	10 MHz LINEAR	Output of 10-MHz IF amplifier. 50 ohms, isolated.
J106	10 MHz LIMITED	Output of 10-MHz IF amplifier after limiting. 50 ohms, isolated.
J107	AUX 2 IN	Input connection to module in fourth position from left of the basic receiver
J108	AUX 2 OUT	Output connection from module in fourth position from left in the basic receiver.
J109	AUX 1 IN	Input for spectrum analyzer This connector should be connected for J104 if the spectrum analyzer is used.

TABLE 2-1. MODEL 410A TELEMETRY RECEIVER CONNECTORS AND FUNCTIONS-continued

Note: All connectors BNC except J113 which is M53102A-145-1S

Ref Desig	Name	Function
J110	AUX 1 OUT	Connector to module in first position from left of the basic receiver.
J111	PBK IN	Input for playback operation.
J112	VIDEO	AM, FM, or PM video output.
J113		Pins: A - AGC
		B - Signal Strength
		C - Ground
		D - Shield for E
		E - Tracking Video (AM)
		F - Carrier Indicator
		G - Phase Lock Indicator

2.3.3 PLUG-IN MODULE INSTALLATION

The plug-in modules are inserted into the front panel of the basic receiver unit and secured in position by a captive screw. Seven spaces are provided for these plug-in modules in addition to the space for the RF tuner. Refer to table 2-2 for the proper location of the plug-in modules. The positions are numbered from left to right as viewed from the front.

TABLE 2-2. PLUG-IN MODULE LOCATIONS, MODEL 410A TELEMETRY RECEIVER

Module	Position
Spectrum Analyzer	The unit operates properly only when installed in the first three positions. J104 and J109 on the rear panel should be connected together.
FM or PM Demodulator	This unit must be inserted in the fifth position.
One IF Filter	When one IF filter is used, insert the unit into position seven.

TABLE 2-2. PLUG-IN MODULE LOCATIONS, MODEL 410A TELEMETRY RECEIVER-continued

Module	Position
Two IF Filters	When two IF filters are used, insert the units into the sixth and seventh positions.
Three IF Filters	When three IF filters are used, insert insert the units into the fourth, sixth, and seventh positions.
Four IF Filters	When four IF filters are used, insert the units into the first, fourth, sixth, and seventh positions. Jacks J107 and J109 must be connected together. Jacks J108 and J110 must be con connected together.
Predetection Record Translator	This unit must be inserted into the first or fourth position. If in the first position, connect J105 to J109. The output is on J110. If in the fourth position, connect J105 to J107. The output is on J108.
Predetection Playback Translator	This unit must be inserted into the first or fourth position. If in the first position, connect J110 to J111. The recorded input must be connected to J109. If in the fourth position, connect J108 to J111. The recorded input must be connected to J109.
Predetection Playback Demodulator	This unit must be inserted into the fifth position. Connect the recorded input to J106.
60 to 30 MHz Converter	This unit must be inserted into the first or fourth position. If in the first position, connect J104 to J109. The output is on J110. If in the fourth position, connect J104 to J107. The output is on J108.

After the units are installed in accordance with table 2-2, secure the units by tightening the captive screw on the front panel of the unit. No internal cable connections are required when installing or removing the plug-in modules. External cable connections are described in table 2-2.

NOTE

Before applying operating power, refer to the operating instructions in section 3.

SECTION 3
OPERATION

3.1 GENERAL

This section contains the procedures for operating the basic receiver unit. Refer to the associated manuals for detailed instructions on plug-in module operation.

3.2 CONTROLS AND INDICATORS

The basic receiver unit operating controls and indicators are listed in table 3-1. The control and indicator locations are shown in figure 3-1. More recent configurations for the FM Demodulator and Pre-Detection Record Translator are shown in figure 3-2 and 3-3, respectively.

TABLE 3-1. CONTROLS AND INDICATORS, MODEL 410A BASIC RECEIVER

Name	Function
Basic Receiver	
SECOND LO TUNING	Tunes the second local oscillator by ±250 kHz and permits fine tuning of the receiver.
SECOND LO MODE	The second oscillator mode of operation is selected with this control. The possible modes are: CAL, (calibrate), VFO, AFC, XTAL, APC, and PBK (playback).
AGC Control	Permits selection between AGC time constant - SLOW (100 ms) and FAST (1 ms).
VOLUME Control	Functions as the power-on-off switch and volume control for the speaker (mounted behind the front panel).
OUTPUT BANDWIDTH Control	Determines the maximum frequency of the signal supplied to the video amplifier. Selection is made from 20, 50, 100, 200, 500, 1000 kHz, and BYPASS.

TABLE 3-1. CONTROLS AND INDICATORS, MODEL 410A
BASIC RECEIVER-continued

Name	Function
Basic Receiver-continued	
OUTPUT RESPONSE Control	Permits selection of ac or dc output.
OUTPUT LEVEL Control	Permits variation of the video output level.
TUNING Meter	Provides an indication of tuning error. Full scale deflection is determined by the deviation setting on the FM demodulator module.
SIGNAL STRENGTH Meter	Provides an indication of the approximate input signal strength measured in microvolts.
DEVIATION Meter	Provides an indication of the peak deviation of the signal from center frequency. Full scale deflection in degrees or kilohertz is determined by the deviation setting on the demodulator module.
OUTPUT LEVEL Meter	Indicates the video output level in volts, peak-to-peak
RF Tuning Head	
Tuning Control	This control is used to tune the receiver.
Tuning Indicator	The frequency to which the receiver is tuned is visible through the window above the tuning dial.
Lock	Mechanically locks tuning dial to prevent accidental changing of the received frequency.
First LO Mode	Permits selection of the first oscillator mode of operation, VFO, XTAL, OFF.

TABLE 3-1. CONTROLS AND INDICATORS, MODEL 410A BASIC RECEIVER-continued

Name	Function
IF Filter	
Frequency Select	This switch is used only when the filters are electrically switchable. Depress the button on the filter front panel to select the filter of the desired bandwidth.
FM Demodulators	
DEVIATION Control	Permits selection of peak deviation. Scales the output of the demodulator and adjusts the full scale deflection of the deviation meter. AM position selects the internal AM demodulator.
DISCRIMINATOR Zero	Zeros the output of the FM demodulator at 10 MHz.
Pre-Detection Record Translator	
CENTER FREQUENCY	Permits selection of the recording center frequency. Switch positions include OFF, 112.5, 225, 450, and 900 kHz.
LIMITER	Limiter ON/OFF is controlled by this switch.
OUTPUT LEVEL	Provides manual control of the output level.

3.3 OPERATION

3.3.1 PRELIMINARY PROCEDURES

Before operating the unit:

a. Ensure that the receiver is properly mounted.

b. Ensure that all plug-in modules are in the correct locations and are securely in position.

c. Ensure that the ac power is connected. Apply power by turning the VOLUME control knob clockwise.

d. Check the crystal and crystal oven for proper operation.

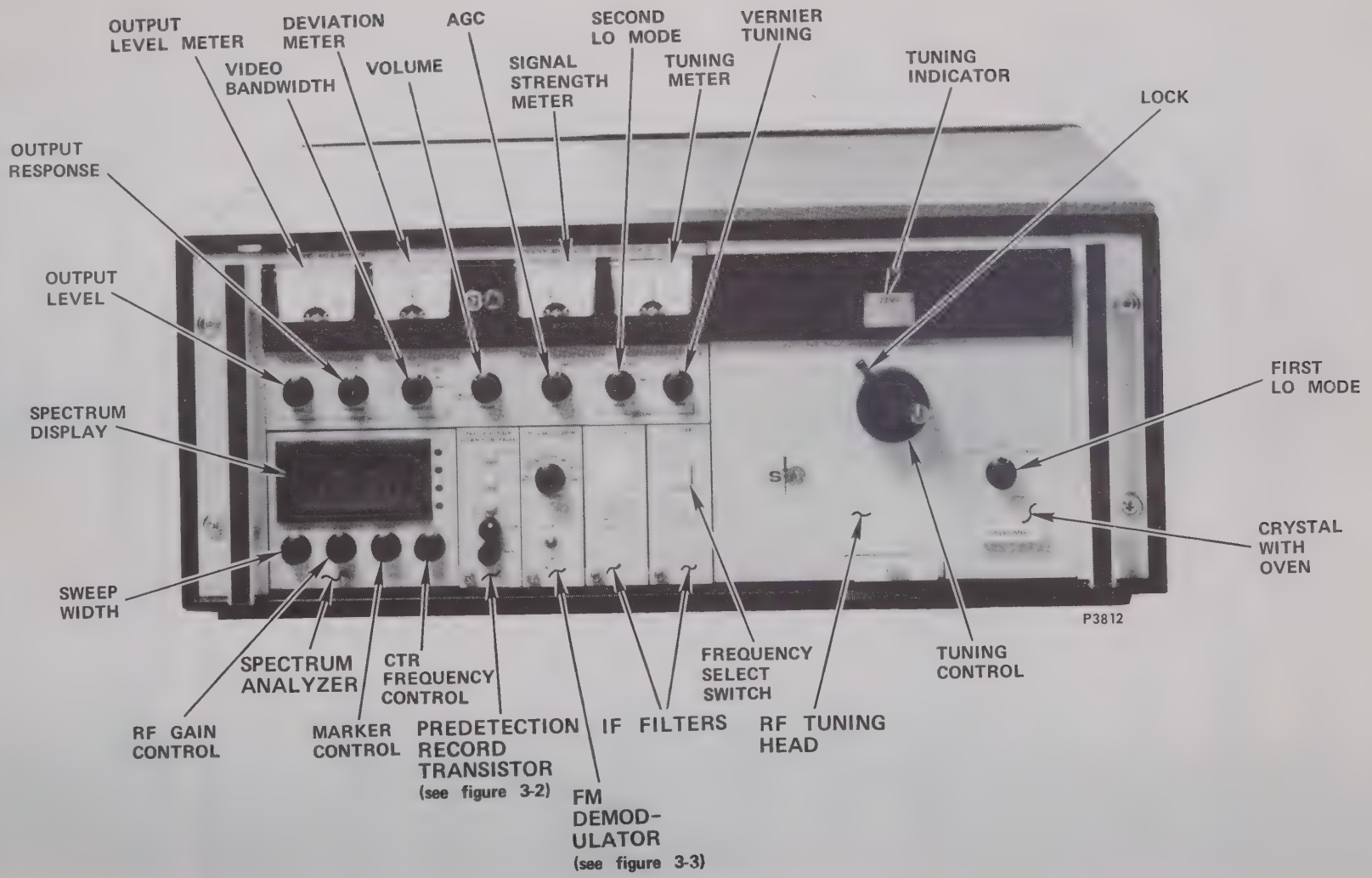


Figure 3-1. Controls and Indicators, Model 410A Telemetry Receiver

Figure 3-2. FM Demodulator

Figure 3-3. Predetection Record Translator

3.3.2 OPERATING PROCEDURES

To operate the unit:

a. Perform the procedures of paragraph 3.3.1.

b. Set the SECOND LO MODE control to the VFO position.

c. Set the VFO-XTAL-OFF switch to the VFO position.

d. Set the AGC time constant to SLOW for AM or tracking application or FAST for FM operation.

e. Adjust the RF tuner tuning control and the SECOND LO TUNING control for a zero indication on the TUNING meter. The TUNING meter should be centered.

f. Set the SECOND LO MODE switch to the AFC position. Variations up to ±250 kHz in frequency of the incoming signal will not affect the tuning when operating in the AFC mode.

g. Adjust the FM demodulator DEVIATION control to the desired position.

h. Set the DEVIATION control to the AM position if amplitude modulation is to be received.

i. Set the output filter bandwidth to the desired video bandwidth.

j. Adjust the OUTPUT LEVEL control to the desired position as indicated by the OUTPUT LEVEL meter.

k. Adjust the VOLUME control to the desired audio level.

3.3.3 TURN-OFF PROCEDURES

To turn off the unit, rotate the VOLUME control counterclockwise until the switch is actuated. The receiver does not incorporate any emergency turn-off procedure.

SECTION 4
THEORY OF OPERATION

4.1 GENERAL

The Series 410 Telemetry Receiver theory of operation is discussed in this section. This discussion is referenced to figure 4-1 and the schematic diagrams in section 5.

4.2 BLOCK DIAGRAM DISCUSSION

4.2.1 GENERAL

The receiver is a double-conversion, superhetrodyne, AM-FM-PM telemetry data receiving system capable of operating at frequencies up to 6 GHz. The basic receiver modules are discussed on a signal-flow basis. The auxiliary plug-in modules are discussed separately.

4.2.2 BASIC RECEIVER MODULES

4.2.2.1 RF Tuner. The RF tuner couples the RF input signal from the antenna to the receiver. Interchangeable tuners permit the receiver to function over frequency ranges up to 6 GHz.

The integrated preselector and double-balanced first mixer give the UHF tuners an extremely high dynamic range with significantly reduced intermodulation. This design, coupled with the use of a 60-MHz first IF, minimizes spurious responses and undesired radiation. VHF tuners provide a wide dynamic range and low noise figures by employing FET (field effect transistor) circuitry.

The RF signal from the antenna is the input to the integrated preselector. The preselector output is one input to the first mixer. The second input to the mixer is the multiplied output from a crystal-controlled oscillator or a variable-frequency oscillator. The first mixer hetrodynes the two inputs to provide a 60-MHz output to the preamplifier. The gain of the preamplifier is controlled by an AGC voltage.

4.2.2.2 Second Conversion. The 60-MHz signal from the RF tuner is the input to the second conversion section. The signal is amplified by the IF amplifier and coupled to the second mixer. The second input to the mixer is the output from the crystal-controlled or variable-frequency second oscillator. The second local oscillator operates in the VFO, AFC, or APC mode to provide vernier tuning. In the playback or calibrate mode the second local oscillator is disabled. The 60-MHz amplifier and second mixer gain is controlled by an AGC voltage developed by the AM demodulator. The 10-MHz output from the second conversion stage is routed to the plug-in type IF filters.

4.2.2.3 IF Filter. The input to the IF filter is the output from the second conversion section. The IF filter is either switch selectable or interchangeable to determine the bandwidth of the receiver. The filters are selected in accordance with the bandwidth to be received. The filters are of the linear phase (Bessel) type to reduce data distortion or the Butterworth type to provide a constant amplitude bandwidth characteristic. Standard bandwidths range from 10 kHz to 3.3 MHz.

4.2.2.4 AM Detector. The 10-MHz output from the IF filter is further amplified by the 10-MHz IF amplifier. The output from the amplifier is coupled to the AM demodulator and the data demodulator. A linear 10-MHz external output is also provided by the amplifier for recording or accessory operation. The AM demodulator provides AM video detection and also an AGC Voltage to control the overall receiver gain. The video output from the AM demodulator is routed through a switch in the data demodulator and applied to the video circuitry.

4.2.2.5 Data Demodulator. The data demodulator is a plug-in type module. The input to the data demodulator plug-in module is the output from the 10-MHz IF amplifier. The limiter provides a 10-MHz external output and an input to the data demodulator. The demodulator provides detection of FM or PM signals. Demodulators are also available to permit reception of all IRIG telemetry formats. The FM demodulators provide high linearity and excellent capture performance. The PM demodulators are characterized by extended carrier tracking thresholds and linear demodulation of PM formats. The output from the data demodulator is routed through a switch and applied to the video circuitry. The switch permits selection of the FM/PM or AM video to be applied to the video circuitry.

4.2.2.6 Video Section. The video signal from the data demodulator is coupled to the video filter. The filters are of the linear phase design, having a selectable

bandwidth from 20 kHz to 2.0 MHz. The output from the filters is coupled to a highly stable video amplifier. The amplifier provides selection of ac or dc coupling in the video output. The amplifier provides the final amplification for the video signal. A sample of the amplifier output video is coupled to the metering section. The video output from the amplifier is routed to the recording or display equipments.

4.2.2.7 Metering Section. The input to the metering section is a sample output from the video amplifier. The metering section provides a display of the signal characteristic and receiver functions. The receiver tuning error is measured in kilohertz and is displayed by the zero center tuning meter. Signal strength, measured in microvolts, is indicated as well as carrier frequency deviation, phase deviation, or percentage of AM modulation. The video output level is indicated directly in volts.

4.2.3 PREDETECTION RECORD TRANSLATOR

The predetection record translator is an auxiliary front panel plug-in module capable of converting the 10-MHz second IF signal to one of four lower frequencies for recording purposes. Output impedance of the translator is 75 ohms.

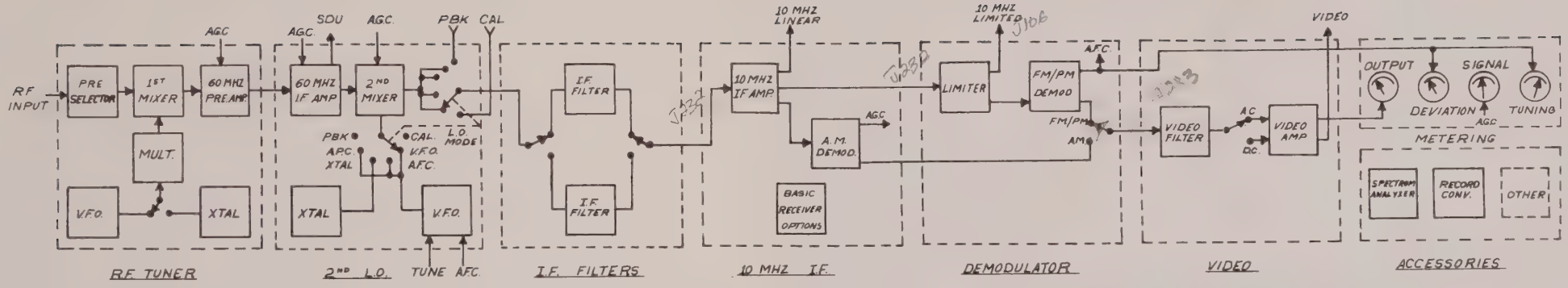


Figure 4-1. Block Diagram, Model 410A Telemetry Receiver

SECTION 5
DIAGRAMS

This section contains schematic diagrams for the Model 410A Telemetry Receiver.

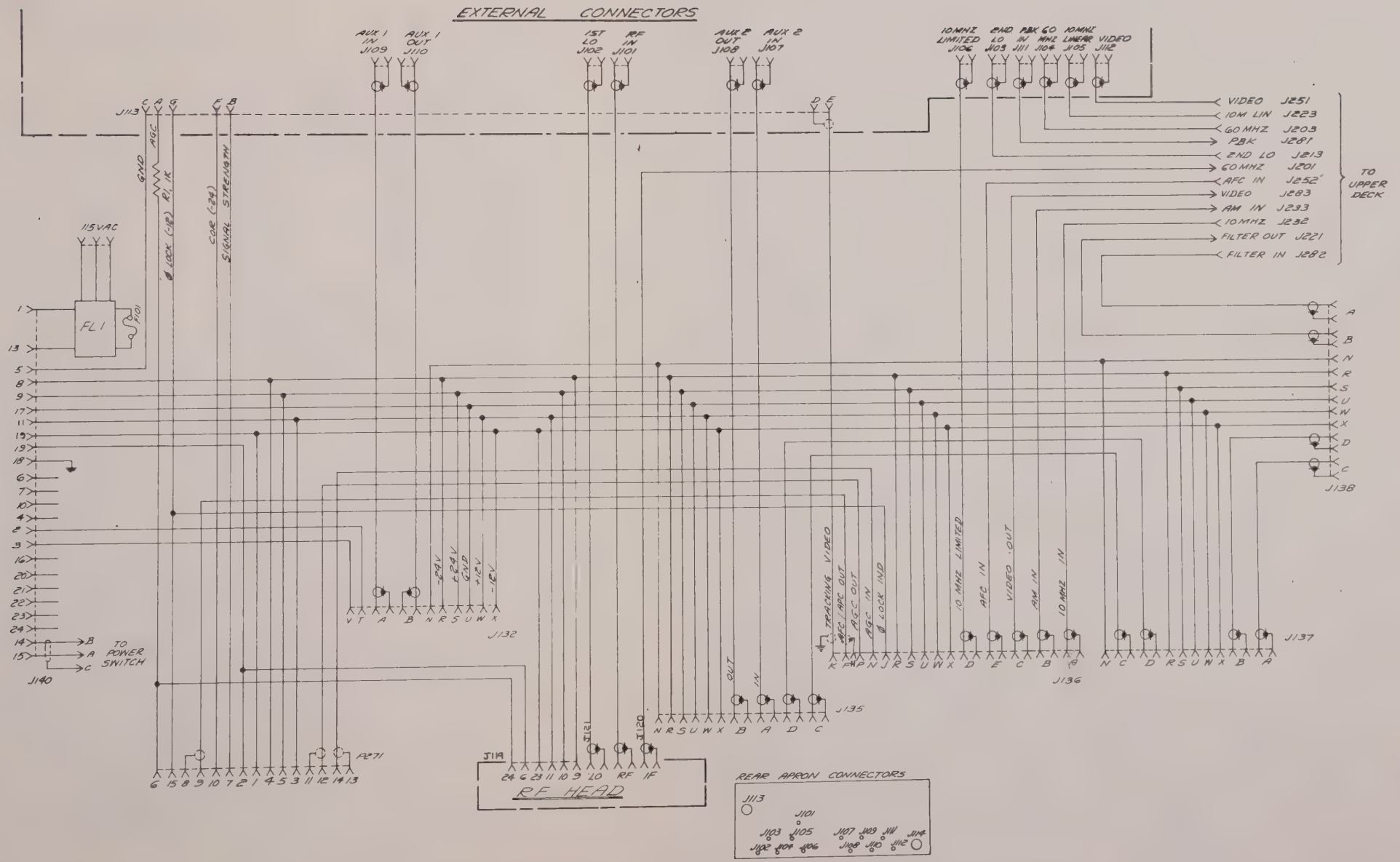


Figure 5-1. Main Chassis Schematic

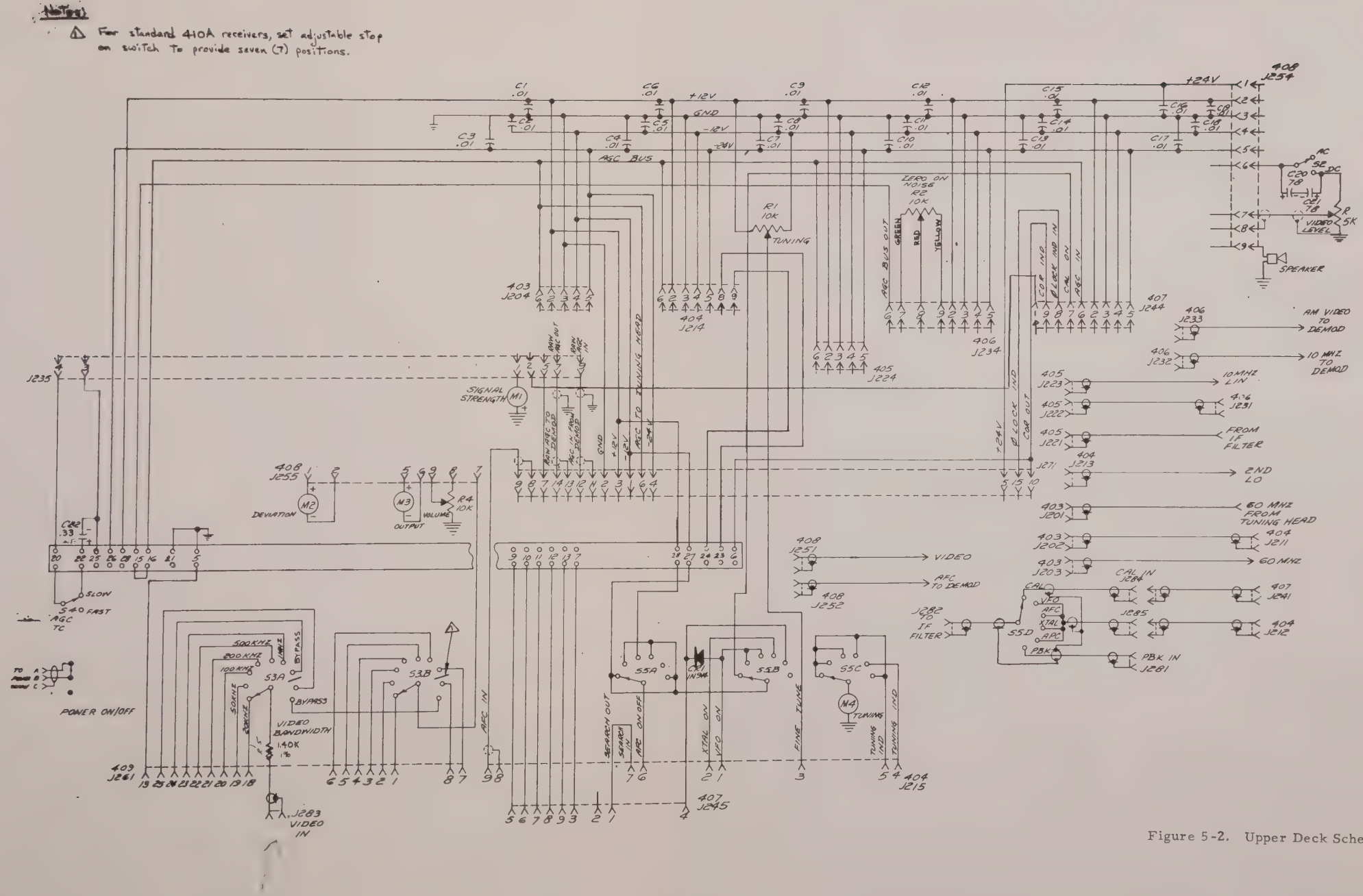


Figure 5-2. Upper Deck Schematic

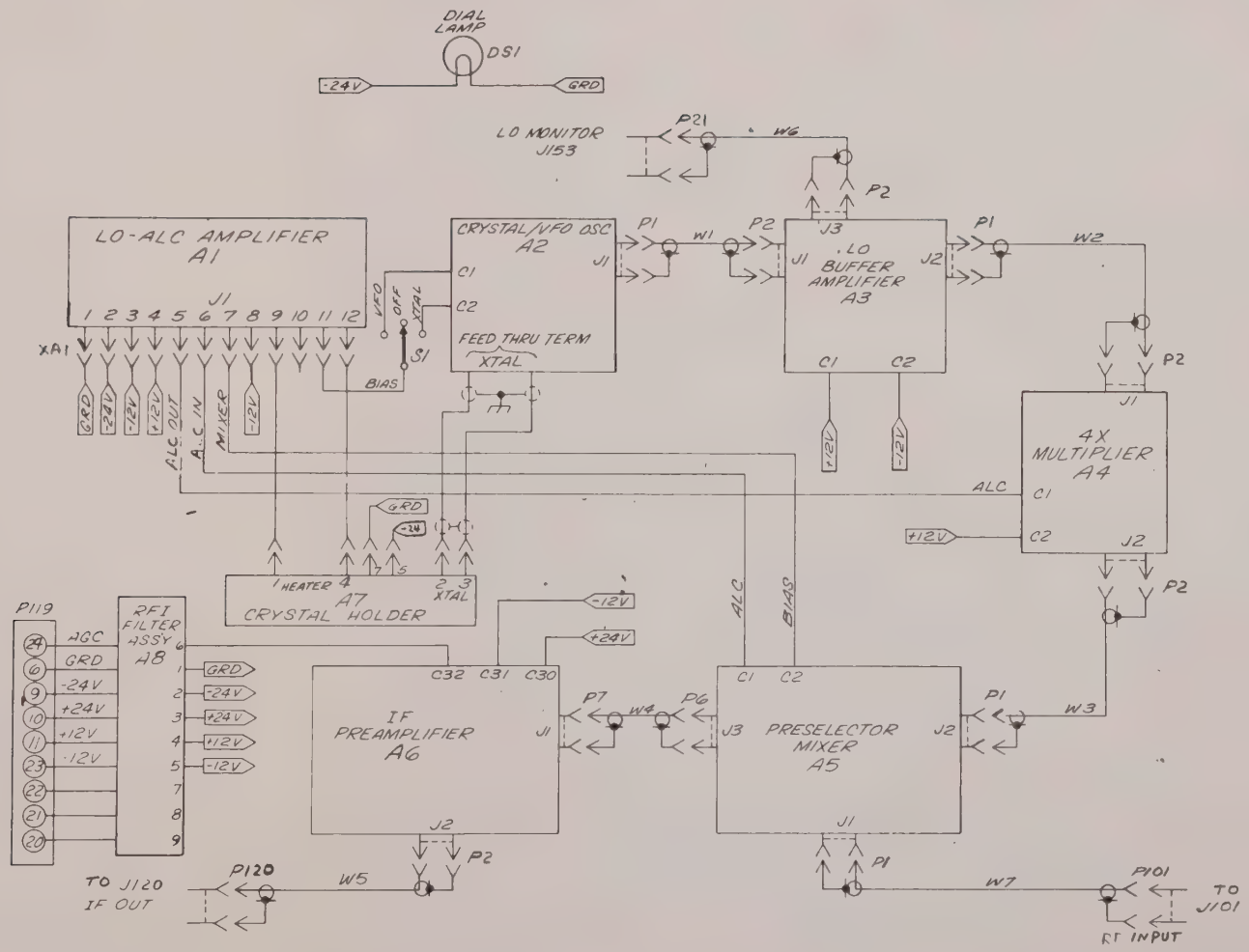
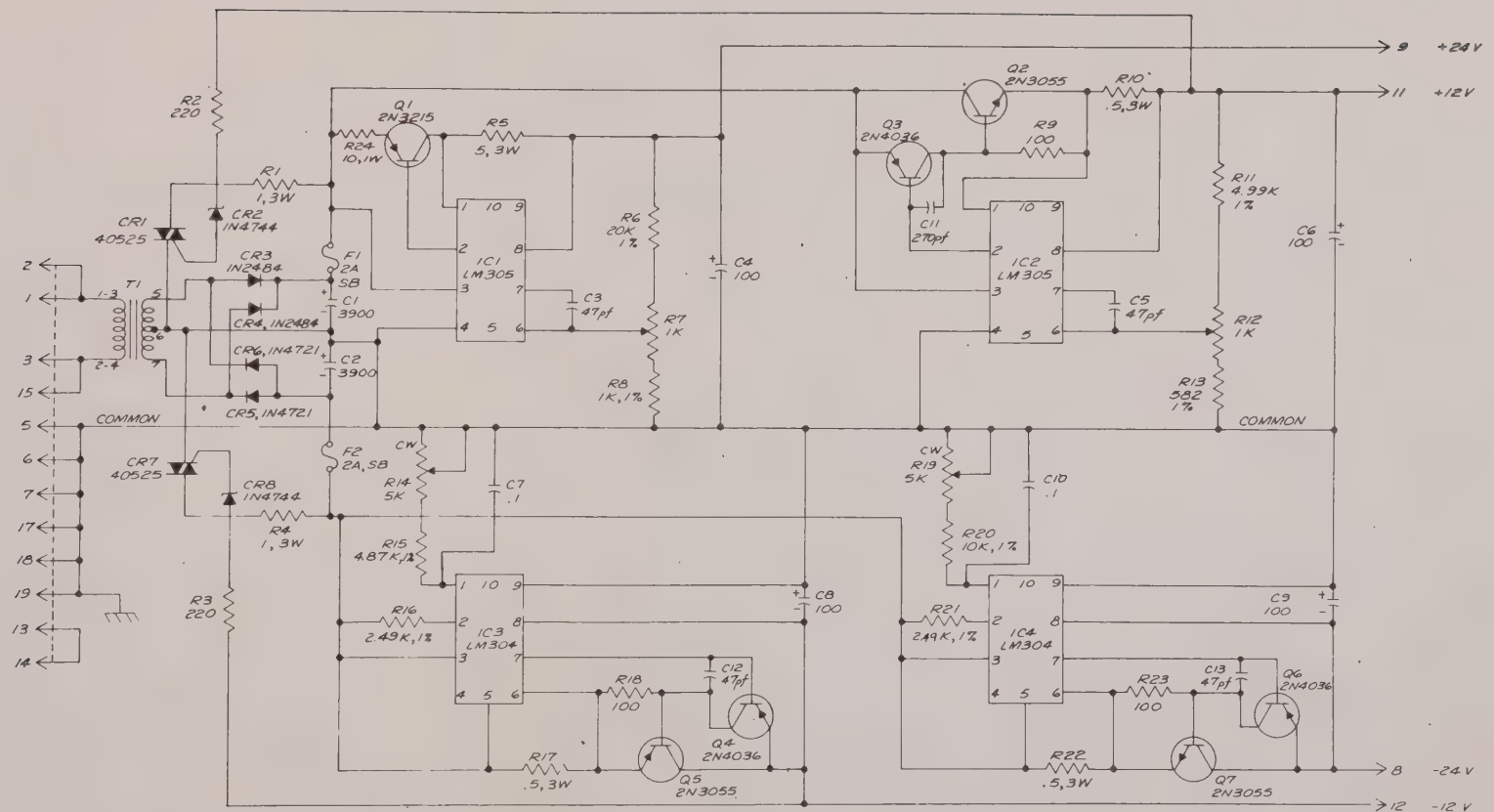


Figure 5-3. RF Tuner Schematic



NOTE:
1. Q1, Q2, Q5, & Q7 ARE NOT ON THE POWER SUPPLY PQ BOARD – 65662

Figure 5-4. Power Supply Schematic

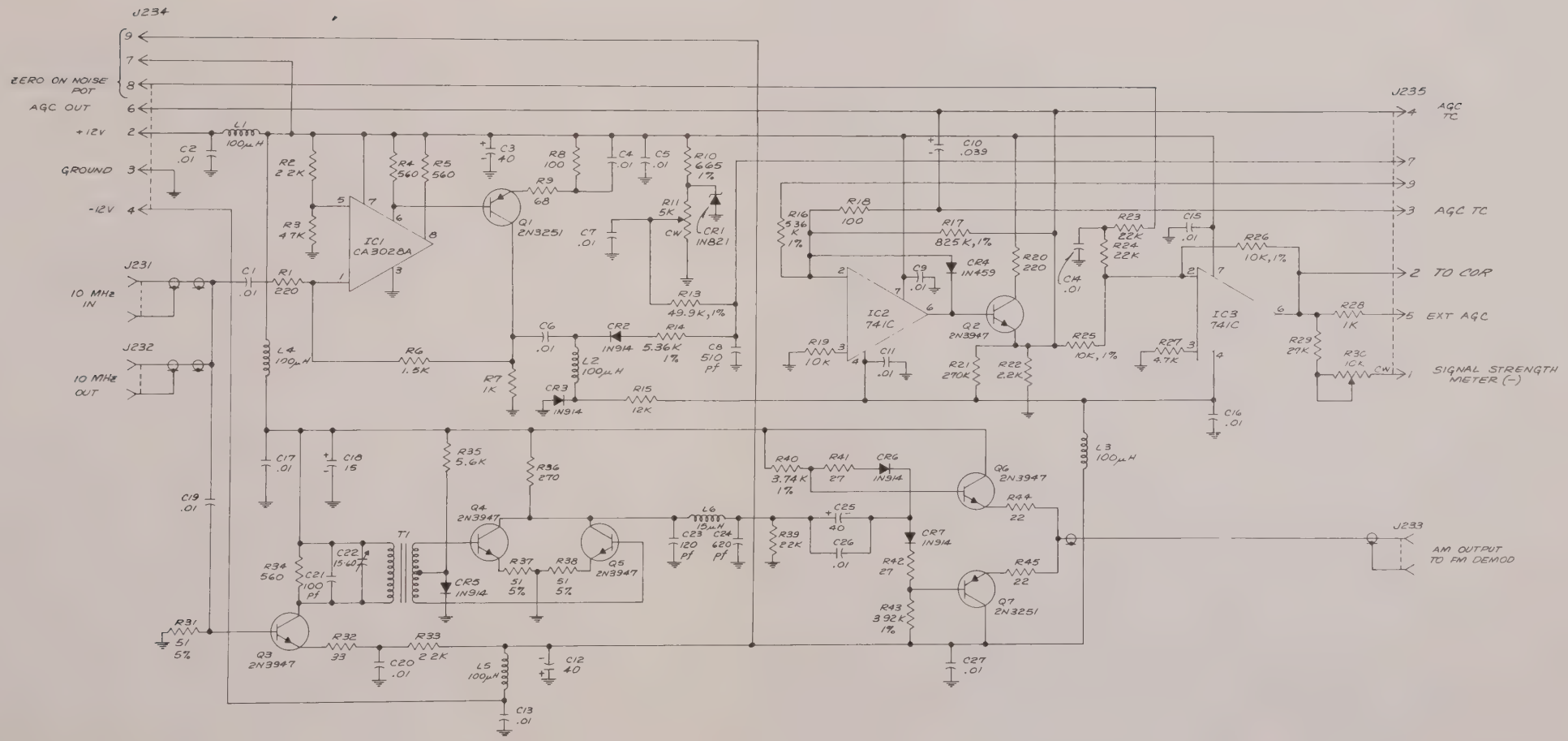
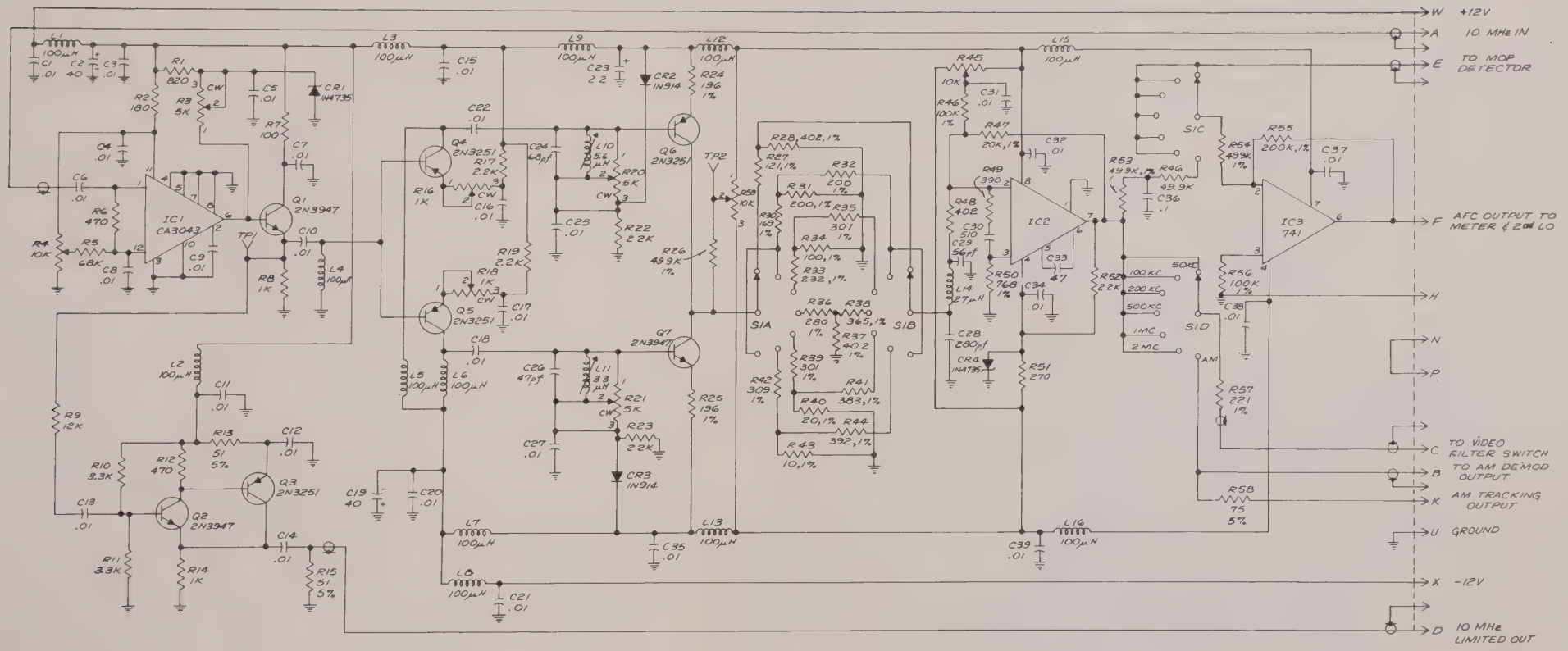


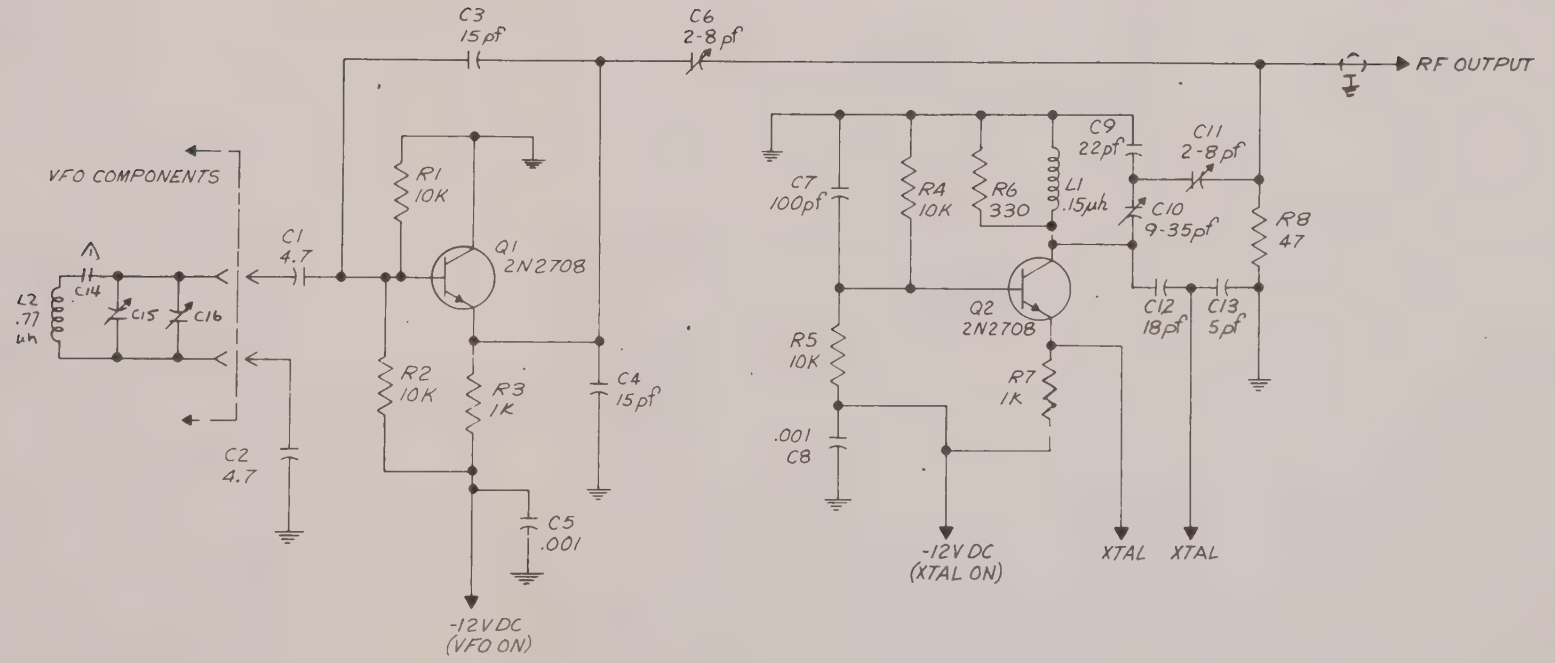
Figure 5-5. AM Demodulator Schematic



NOTE: 1. SWITCH S1 SHOWN IN POSITION 1 (50KHz)

Figure 5-6. FM Demodulator Schematic

J 283 VIDEO F... OUT
P 283 FM DEMOD OUTPUT



NOTE:

△ 18 pf MODEL 422
15 pf MODEL 423

Figure 5-7. XTAL/VFO Oscillator Schematic

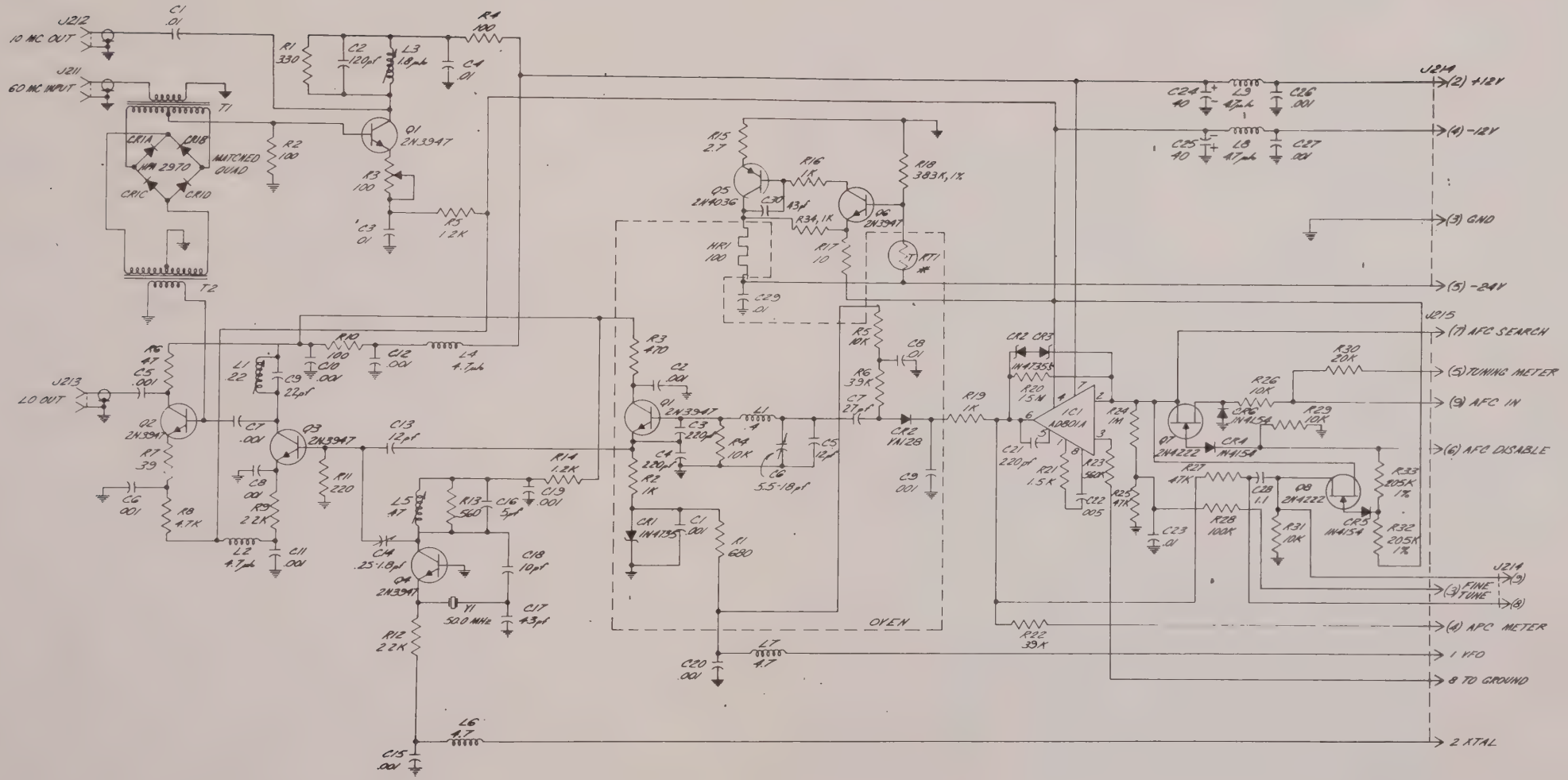
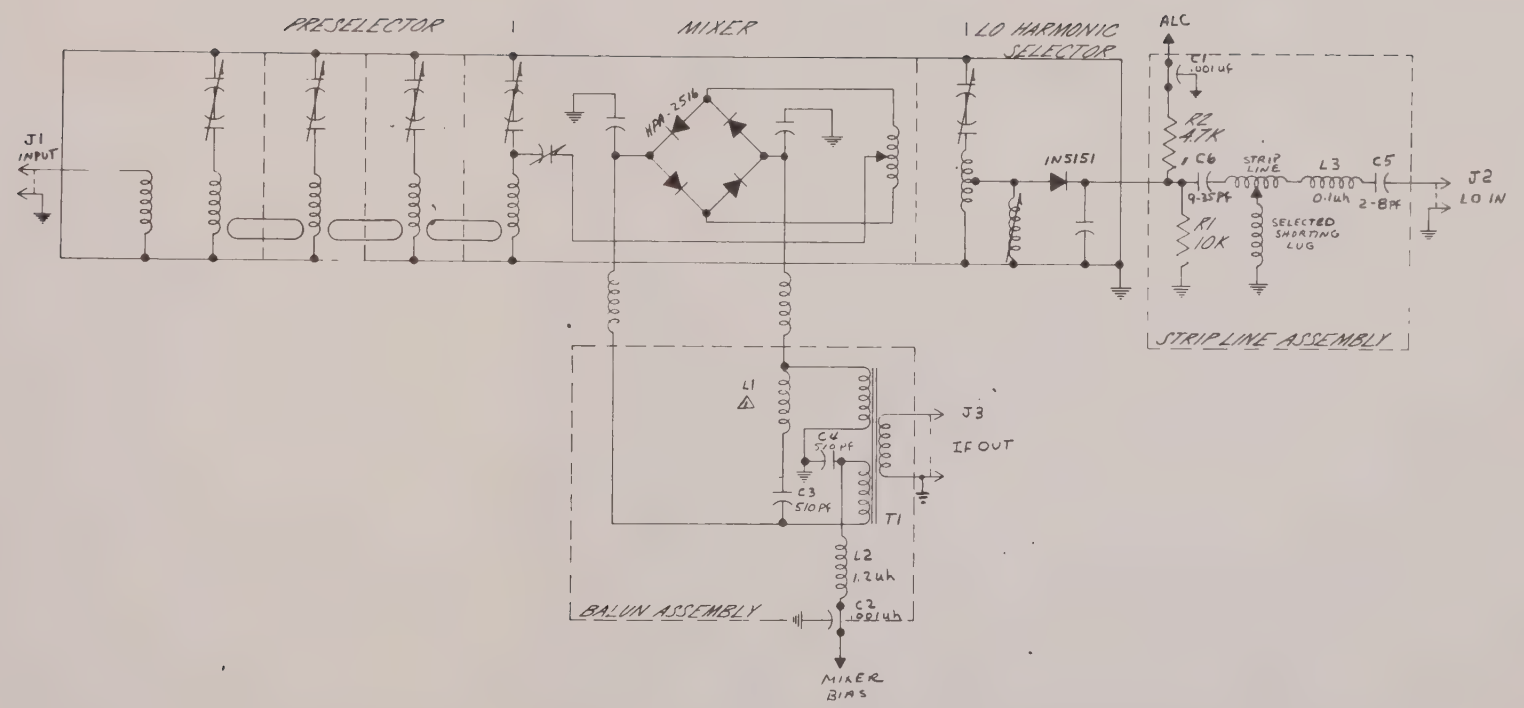


Figure 5-8. Second Converter Schematic



⚠1
.33uh FOR 60 MHZ IF
.1uh FOR 105 MHZ IF

Figure 5-9. Preselection Mixer Schematic

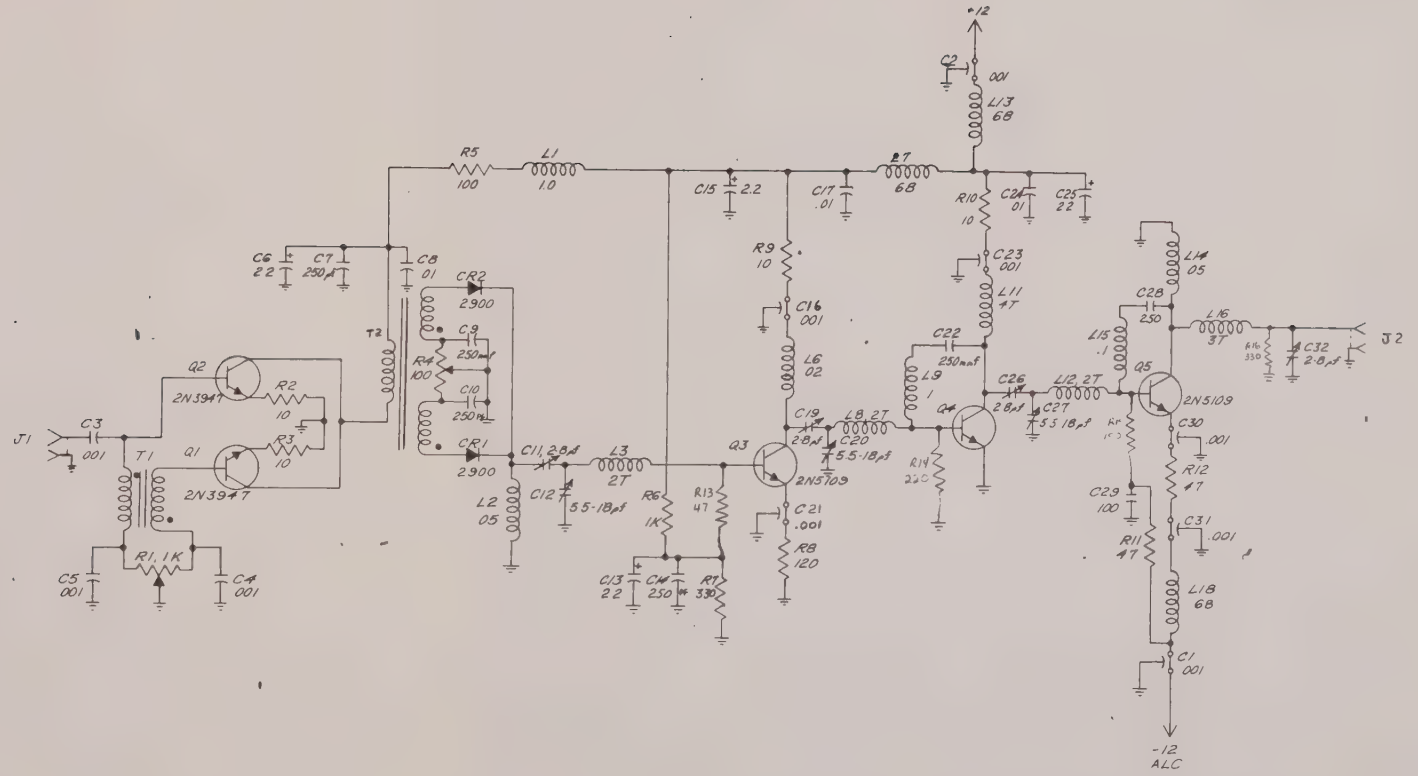
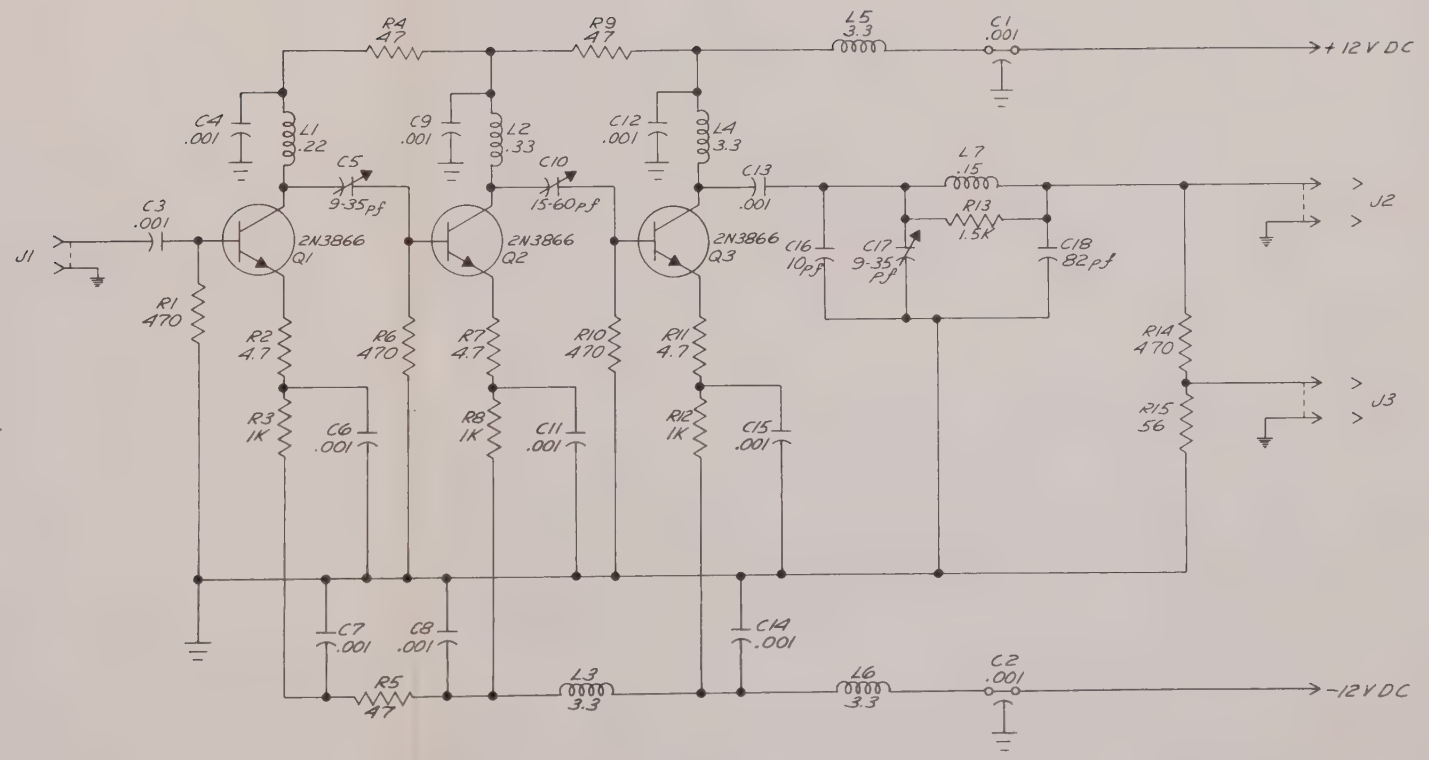


Figure 5-10. Multiplier Schematic



NOTE:
1. ALL COIL VALUES IN μH

Figure 5-11. LO Buffer Amplifier Schematic

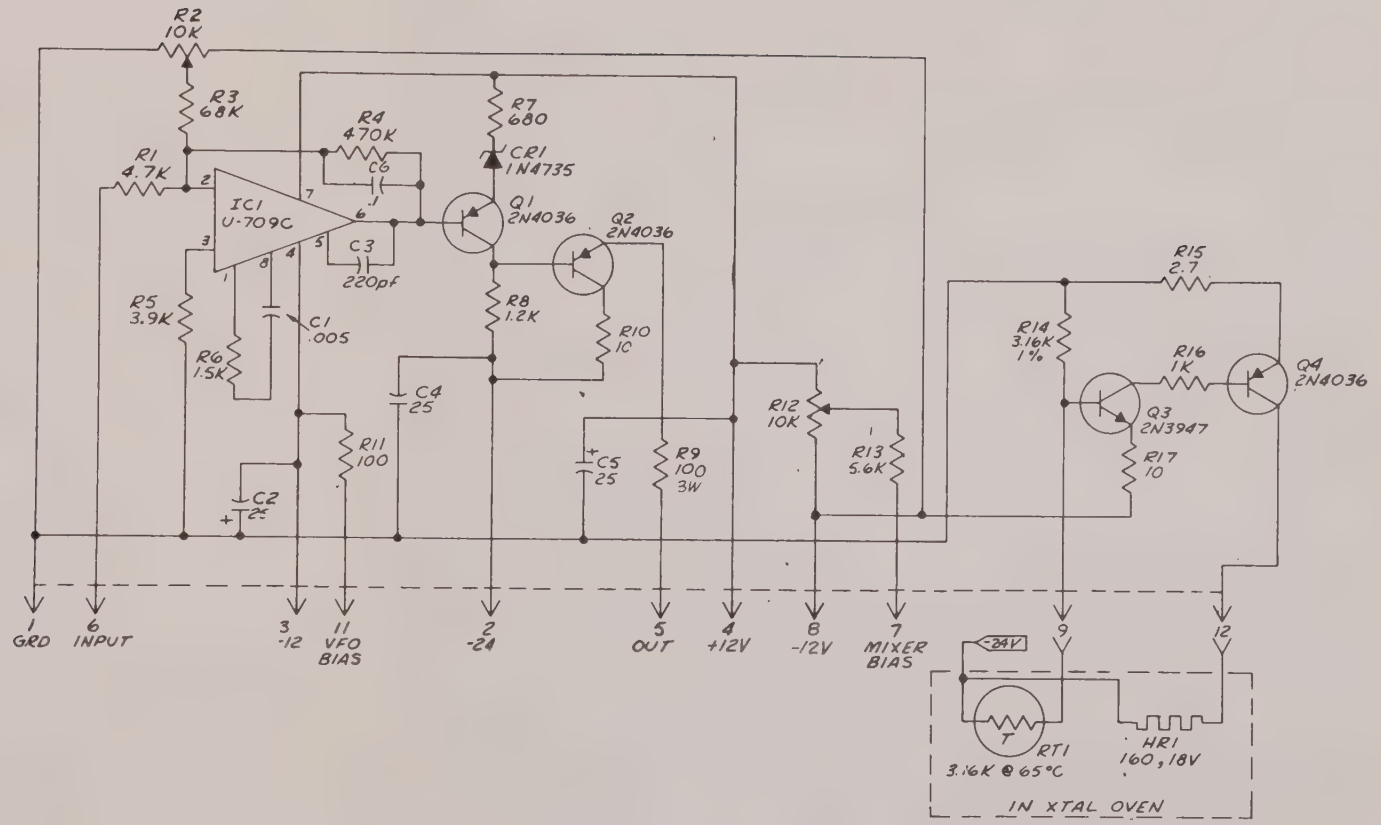


Figure 5-12. LO-ALC Amplifier Schematic

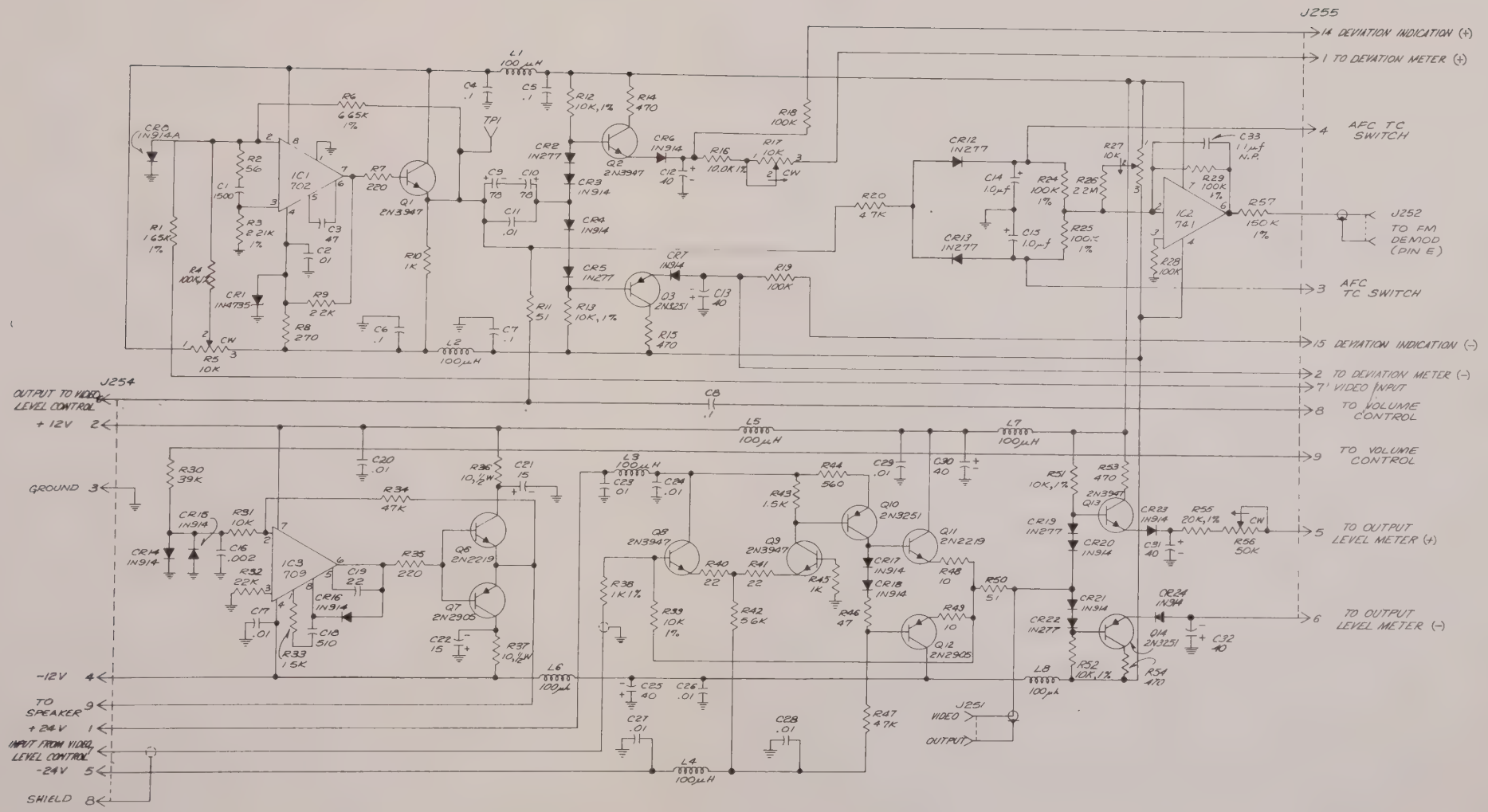


Figure 5-13. Video Amplifier Schematic

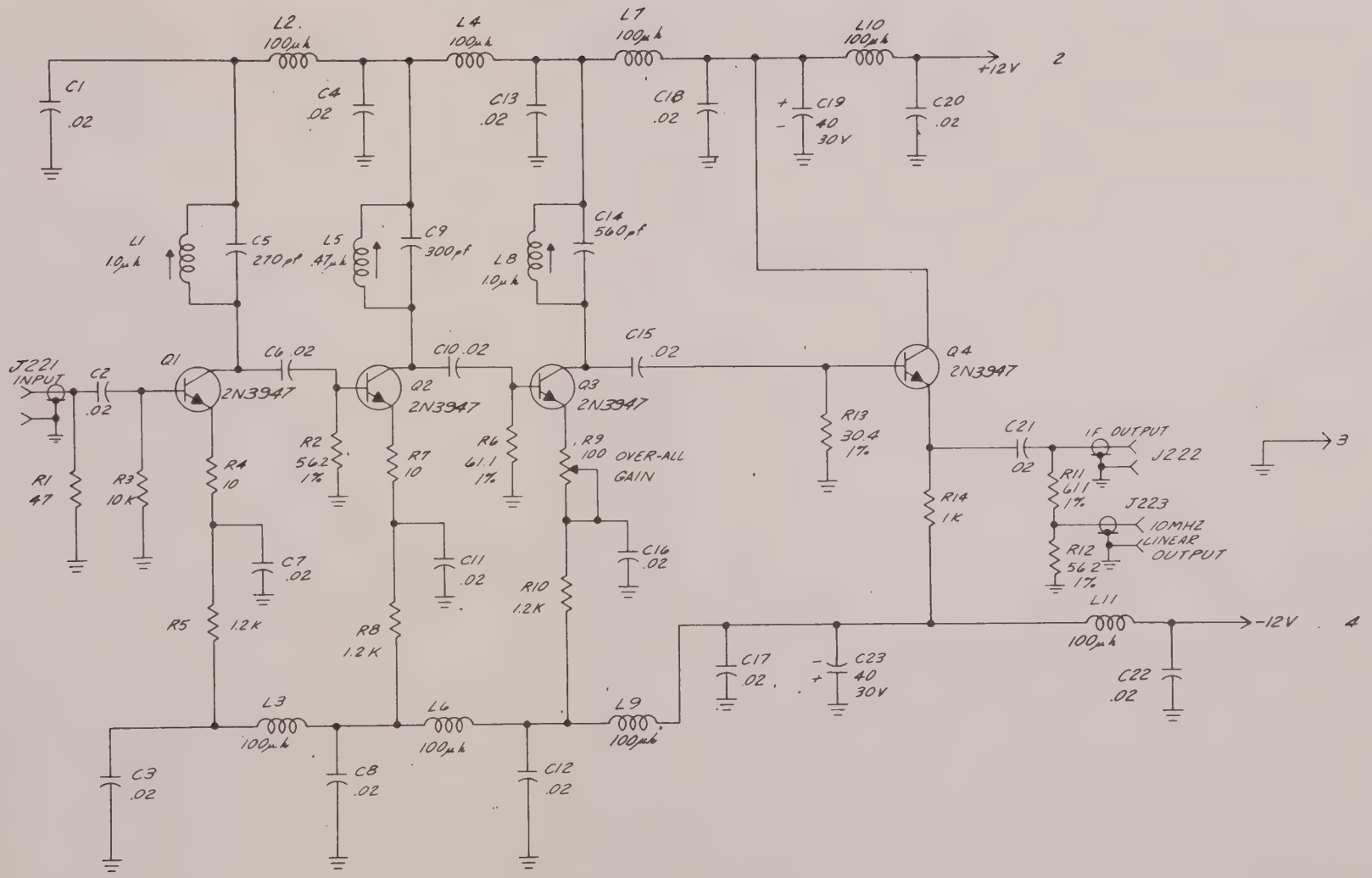
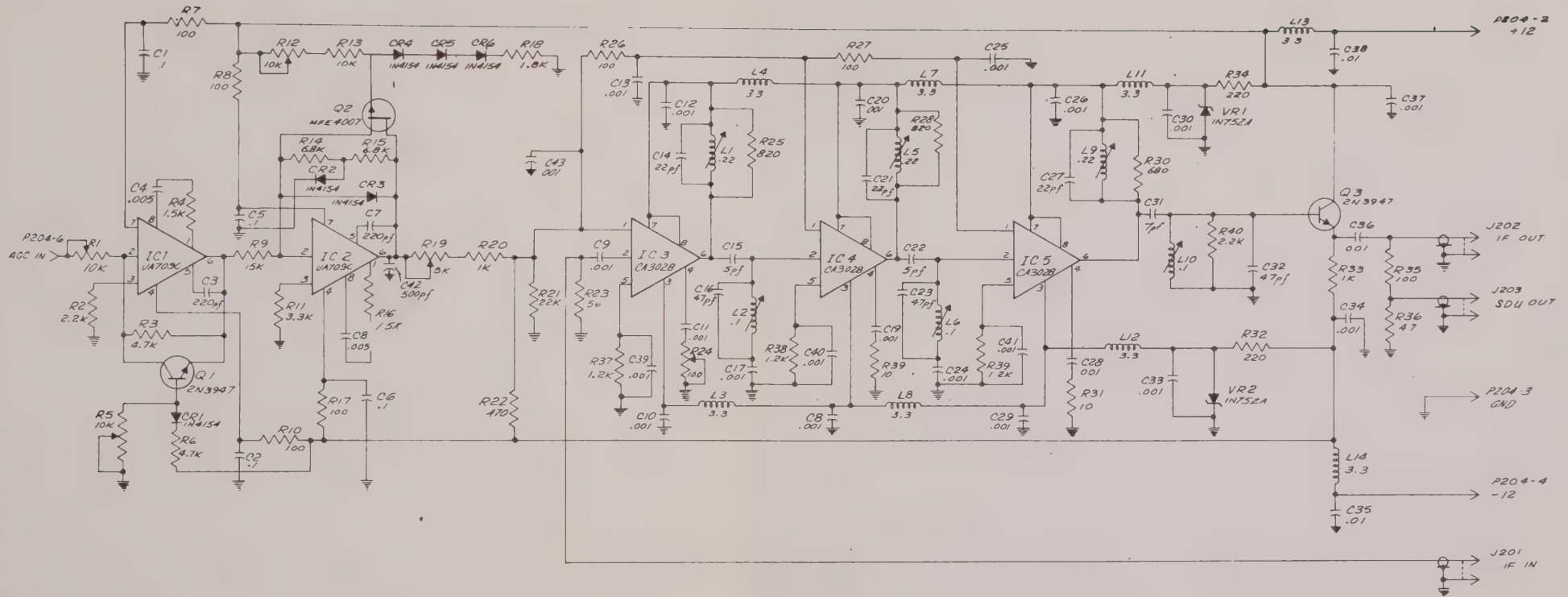


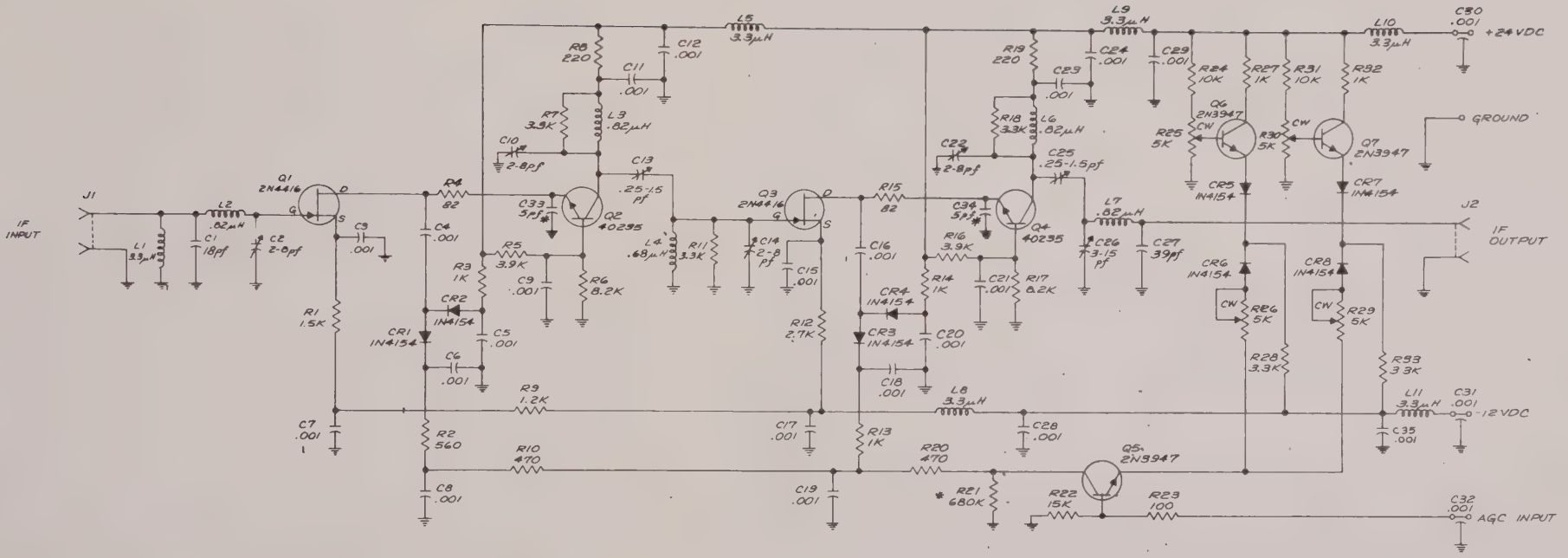
Figure 5-14. IF Amplifier, 10 MHz, Schematic Diagram



NOTE

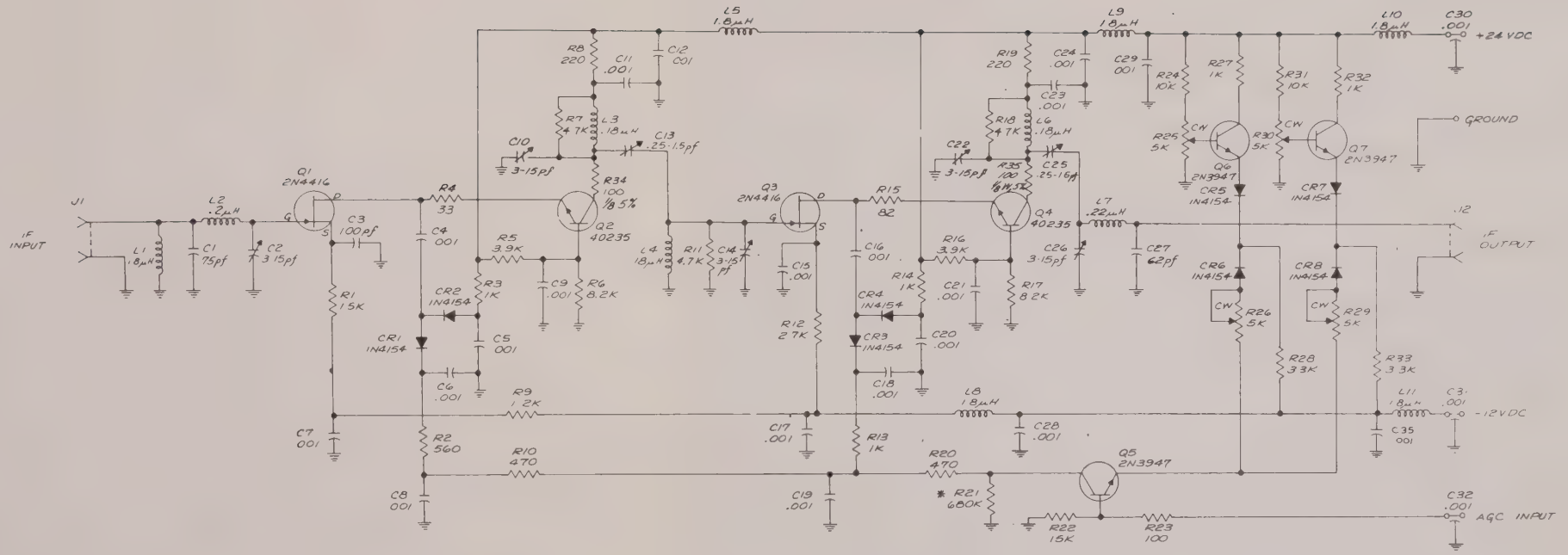
ALL INDUCTORS IN MICRO HENRYS.

Figure 5-15. IF Amplifier, 60 MHz, Schematic Diagram



NOTE:
1. * FACTORY SELECTED
2. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

Figure 5-16. IF Preamplifier, 60 MHz, Schematic Diagram



NOTE:
1. * FACTORY SELECTED
2 PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH UNIT NUMBER OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

Figure 5-17. IF Preamplifier, 105 MHz, Schematic Diagram

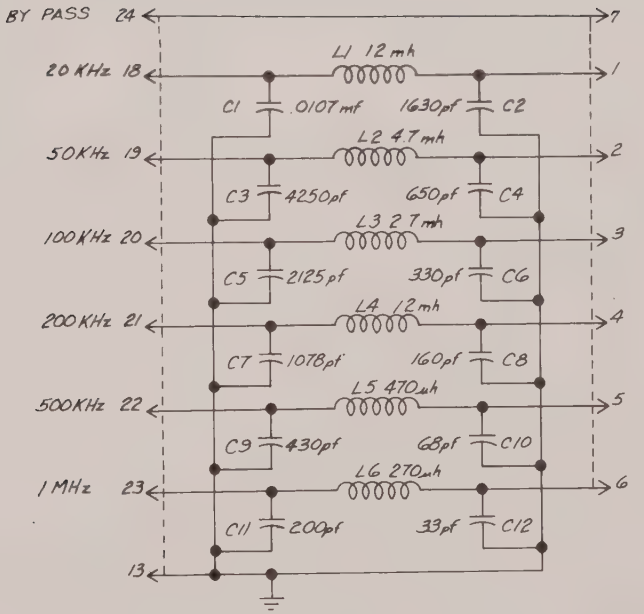
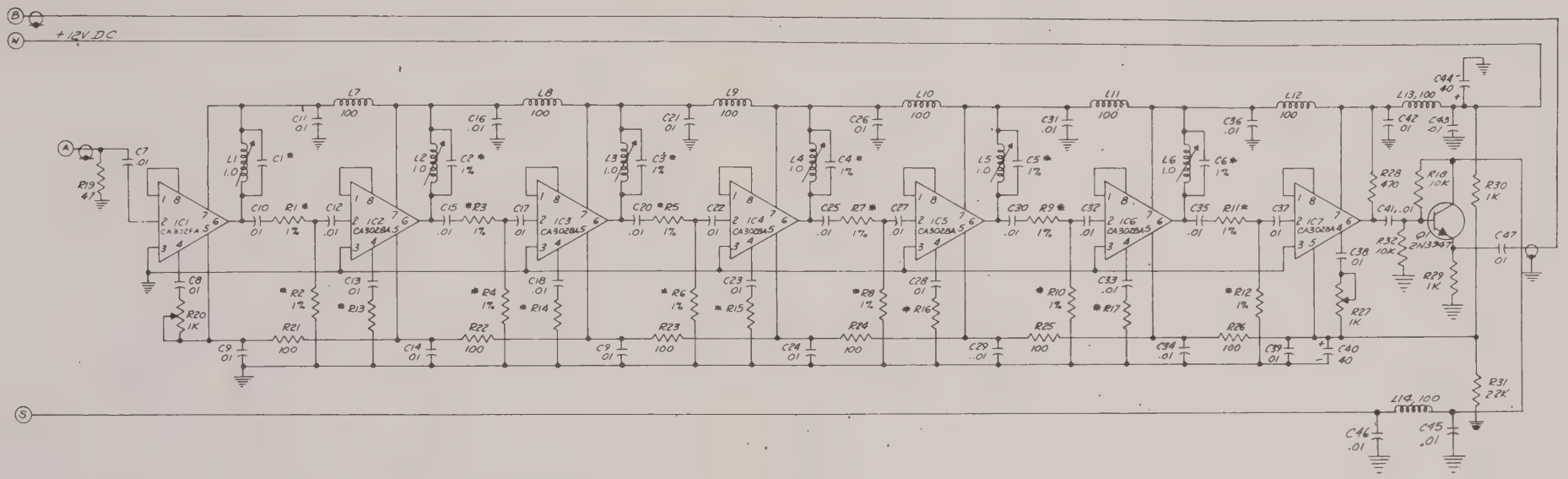


Figure 5-18. Video Filter Schematic



NOTE:

1. * – VALUE DEPENDENT ON FILTER BANDWIDTH
2. ALL INDUCTANCES IN MICROHENRIES UNLESS OTHERWISE SPECIFIED

Figure 5-19. IF Filter, Nonswitchable, Schematic Diagram

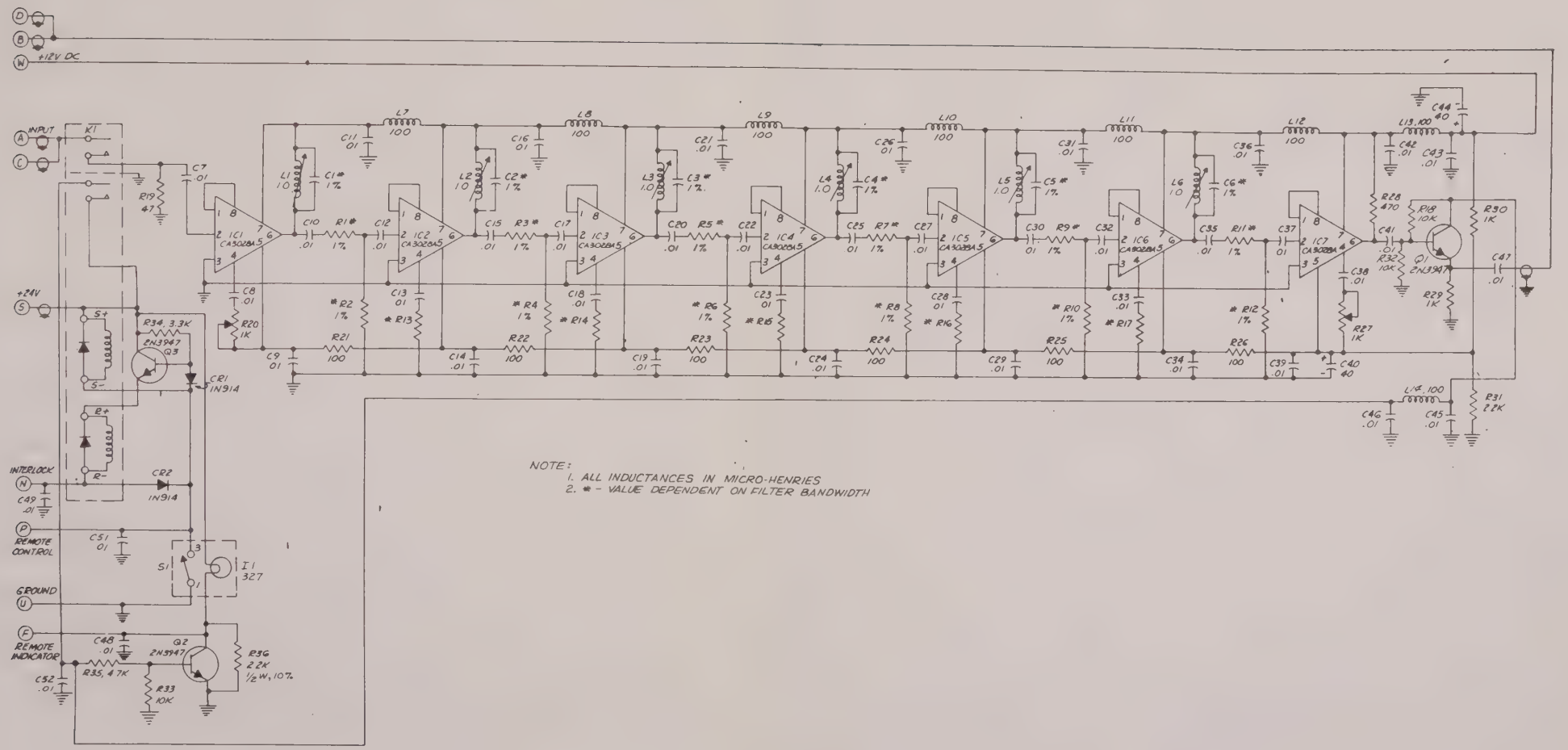


Figure 5-20. IF Filter, Switchable, Schematic Diagram

CONVERSION OF VOLTAGE AND POWER RATIOS TO DECIBELS

The basic chart below indicates the number of decibels (dB) corresponding to the listed ratios of voltage or power over the range of −20 to +20 dB. For voltage or power ratios greater than those included in the chart, the ratio can be broken down into a product of two numbers, the value in dB for each found separately, and the two results added. Example: To convert a power ratio of 2,000:1 to dB, express 2,000 as 2×10^3; the number of dB corresponding to a power ratio of 2 is very nearly 3, and the number of dB for a power ratio of 10^3 is 30. Therefore, the power ratio of 2,000:1 is approximately 30 dB + 3 dB = 33 dB. In the lower righthand corner of the chart dB values for voltage and power ratios of integral powers of 10 are given.

Voltage Ratio	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB+*	*Voltage Ratio*	*Power Ratio*
1.000	**1.000**	**0**	**1.000**	**1.000**	**.447**	**.200**	**7.0**	**2.239**	**5.012**	**.200**	**.0398**	**14.0**	**5.012**	**25.12**
.989	.977	.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28.18
.933	.871	.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28.84
.923	.851	.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	**.794**	**1.0**	**1.122**	**1.259**	**.398**	**.159**	**8.0**	**2.512**	**6.310**	**.178**	**.0316**	**15.0**	**5.623**	**31.62**
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33.11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35.48
.832	.692	1.6	1.202	1.445	.372	.138	8,6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37.15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	**.631**	**2.0**	**1.259**	**1.585**	**.355**	**.126**	**9.0**	**2.818**	**7.943**	**.159**	**.0251**	**16.0**	**6.310**	**39.81**
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46.77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6.918	47.86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	**.501**	**3.0**	**1.413**	**1.995**	**.316**	**.100**	**10.0**	**3.162**	**10.000**	**.141**	**.0200**	**17.0**	**7.079**	**50.12**
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.161	51.29
.692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
.684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53.70
.676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57.54
.653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58.88
.646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7.762	60.26
.638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
.631	**.398**	**4.0**	**1.585**	**2.512**	**.282**	**.0794**	**11.0**	**3.548**	**12.59**	**.126**	**.0159**	**18.0**	**7.943**	**63.10**
.624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8.035	64.57
.617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
.610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8.222	67.61
.603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69.18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70.79
.589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
.582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.846	14.79	.116	.0135	18.7	8.610	74.13
.575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75.86
.569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.936	15.49	.114	.0129	18.9	8.811	77.62
.562	**.316**	**5.0**	**1.778**	**3.162**	**.251**	**.0631**	**12.0**	**3.981**	**15.85**	**.112**	**.0126**	**19.0**	**8.913**	**79.43**
.556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19.1	9.016	81.28
.550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	.110	.0120	19.2	9.120	83.18
.543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16.98	.108	.0118	19.3	9.226	85.11
.537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9.333	87.10
.531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	.106	.0112	19.5	9.441	89.13
.525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19.6	9.550	91.20
.519	.269	5.7	1.928	3.715	.232	.0537	12.7	4.315	18.62	.104	.0107	19.7	9.661	93.33
.513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	.102	.0105	19.8	9.772	95.50
.507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9.886	97.72
.501	**.251**	**6.0**	**1.995**	**3.981**	**.224**	**.0501**	**13.0**	**4.467**	**19.95**	**.100**	**.0100**	**20.0**	**10.000**	**100.00**
.496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20.42					
.490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89		10^{-3}	30		10^3
.484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38	10^{-2}	10^{-4}	40	10^2	10^4
.479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21.88					
											10^{-5}	50		10^5
.473	.224	6.5	2.113	4.467	.211	.0447	13.5	4.732	22.39	10^{-3}	10^{-6}	60	10^3	10^6
.468	.219	6.6	2.138	4.571	.209	.0437	13.6	4.786	22.91		10^{-7}	70		10^7
.462	.214	6.7	2.163	4.677	.207	.0427	13.7	4.842	23.44	10^{-4}	10^{-8}	80	10^4	10^8
.457	.209	6.8	2.188	4.786	.204	.0417	13.8	4.898	23.99		10^{-9}	90		10^9
.452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55					
										10^{-5}	10^{-10}	100	10^5	10^{10}
											10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^6	10^{12}

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